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The Mining Magazine

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EDITORIAL

LAST month we recorded the dissatisfaction expressed in many quarters in connexion with the conferment of a peerage on Sir Joseph B. Robinson. Since then a protest has been made in the House of Lords by Lord Harris, who was supported by Viscount Buxton and the Earl of Selborne. Lord Harris is thoroughly versed in South African mining and finance, and his supporters have held the office of Governor-General of South Africa. The result of the protest is that Sir Joseph Robinson has begged to decline the offer. As far as he is concerned the incident is apparently at an end, but the Government is still confronted with a general expression of popular disgust at the secrecy and intrigue associated with canvassing for the bestowal of honours both by possible recipients and by those who have the power to recommend their grant. It is clear that some new system will have to be adopted if honours are to serve the high purpose for which they are ordained. For instance, all proposals might be placed before an independent committee of the Privy Council. At any rate, conferment of honours on residents in the Dominions should only take place with the privity or by the recommendation of a Colonial prime minister.

RUSTLESS steel formed the subject of one of the discussions at the meeting of the Institution of Mining Engineers held at Sheffield last month, when Dr. W. H. Hatfield gave an outline of the subject and urged mining engineers to adopt ropes and springs made of this material. It will be remembered that when Mr. Harry Brearley invented this class of steel, which is high in chromium, its application was chiefly recommended for the manufacture of cutlery. The steel is, however, too hard to serve as the ideal material for carving purposes, and for the same reason engineers have doubted its applicability to the manufacture of ropes and springs. As for its use for structural purposes, its present high cost has stood in the way of its application in this direction. A year or so ago we recommended constructional steel makers to consider the possibility of making cages and skips of special steel, but they generally reported that the cost would be too high. Dr. Hatfield in his remarks said that if there was a large demand for chromium rustless steel it could be made very much cheaper than at present. The supply of chromium ores is sufficiently great to prevent chromium steel from being classed among high-priced alloys. Dr. Hatfield also stated that, though ropes and springs could be made of this material, their strength was lower than that of the best steel at present employed. Another drawback to the use of chromium steel in mines is that it is attacked by sulphurous and sulphuric acids. The researches in connexion with rustless steel are, however, only in their infancy, and Mr. Brearley, Dr. Hatfield, and others may yet find a series of rustless steels of wide application in mining.

Salaries for Young Engineers

A correspondent writing elsewhere in this issue protests against the miserable salaries often or indeed usually offered to young graduates of the Royal School of Mines or similar colleges. He instances the case of an Associate, who, after being at the war, completed his course at the age of 25, only to be offered a position in an Eastern tropical country at £230 a year without board. This grievance is far from being a new one, but naturally it is most noticeable in lean times like the present when the companies and other employers cannot afford to pay a satisfactory wage or even to maintain an adequate staff.

The question of professional remuneration is not much different in mining from any other circles. Unless the young graduate has connexions or is unusually brilliant, he does not find it easy to make a start at all. The most expensive of all educations, that of a physician or surgeon, yields little subsequent recompense unless a practice or partnership can be bought, or unless by special aptitude the position of house surgeon can be used as a stepping stone. As regards the law, waiting for a brief is a characteristic jape. Then, again, access to a profitable position in the Church requires, as a rule, something more than a college degree. Thus without influence a congenial berth is not easily found by a young mining graduate, and even with influence it is not likely that the salary will be anything to boast of for the first year or two, or until the graduate's character and abilities show themselves.

It is true that young graduates who have done well in the geology and chemistry of oil are obtaining gratifying offers at present; but this is a special case, the scarcity of specialists in this direction and the comfortable financial circumstances of the oil companies accounting for this apparent liberality of terms.

The discontent which is at the base of the whole matter arises in most cases from the mistaken idea that a college education fits the graduate at once for a position of responsibility. Some young graduates go so far as to suppose that they never need do any hard pioneer work, but that they can immediately commence practice as consulting engineers or become critics of other men's work. Even when such students condescend to accept a subordinate post, they are anxious to show their superiority by airing their opinions and recommendations without being fully conversant by experience with the matters immediately in hand. Naturally those who hope for too much from their college training are disappointed to find that they are really only at the beginning of their career when they have acquired their degree or diploma; in other words, that they are not full-fledged practitioners, but men who are qualified to put their training to some useful service. There are some subjects which can be learned better at college than in the field, such as surveying, chemical analysis, mineralogy, mathematics, and the principles of mechanics and physics. Knowledge in one or all of the first three mentioned provides as a rule the first opportunity of employment for the graduate, while his grounding in the other subjects helps him to benefit subsequently from his contact with engineering and geological problems. After having once obtained a foothold, his subsequent career depends upon what opportunities offer, or rather what opportunities he can recognize and pursue. But hard and faithful work must be added to knowledge if success and confidence is to be won.

In discussing this question of commencing salaries with a well-known and successful mining man, who happened to come into our office while we were writing the foregoing, we found that he had gone abroad to take a job at £20 a month directly after he had obtained his A.R.S.M., and that he would have gone for £10 if that was all that was offered. He also informed us that he had that morning fairly pushed a young graduate off the cliffs in order to make him go to a foreign country to a position worth £30 a month.

The question of mining salaries is not a simple one, and while on general principles the action of the Institution of Mining and Metallurgy in drawing the attention of the mining companies to the poor pay offered to clever men is to be commended, yet there are so many other factors in the case at present that a definite movement in this connexion is impossible. The law of supply and demand holds good, and if there are more men available than are required the salaries offered will be low. But the fact that there are more men than jobs is due to the restricted market for base metals and to the impossibility of increasing the gold output owing to the scarcity of capital and the high costs. At the present time, therefore, it seems the right policy for the young graduate (and for the older engineer also) to take whatever offers. It is better to work for little than to rust, and more opportunities for advancement come to those in employment than to those who are still looking for something more suitable to turn up. When times improve and mining is prosperous once more, we may examine this question again, though it is probable that under such conditions the grievance will have been removed automatically.

The Mining Finance Companies

The meetings of a number of companies concerned in the finance of mining operations and the support of quotations on the share-market have been held during the past month, and the respective chairmen have taken the opportunity of reviewing the present position of the mining industry and the conditions that influence it. Among those who have given their views have been Sir Lionel Phillips, at the meeting of the Central Mining and Investment Corporation; Mr. H. Guedalla, at the meeting of the National Mining Corporation; and Mr. F. A. Govett, at the Zinc Corporation and the Lake View Investment Trust meetings; and we must also include Mr. Walter McDermott, who gave one of his characteristically illuminating addresses to the shareholders of the Consolidated Mines Selection Company in May.

To take the National Mining Corporation first. In this case the financial position in which the company finds itself is adequately suggestive of the times through which we are going. The company was

formed toward the end of 1919, during the boom period succeeding the war, a boom which we know now to have been unreal and unjustifiable. But such is the waywardness of the average speculator in mines or mining operations that companies like the National Mining can only be formed and floated when things are booming. Subsequently come the years when slackness and depression prevail, and the realizable value of the company's assets shrink, often equally unwarrantably. Thus National Mining has found it necessary to reduce its capital, and the Court is being petitioned for leave to write down the £1 shares, 10s. paid, to 8s. credited with 4s. paid. This uncalled capital had been a serious matter which had a very adverse effect on the popularity of the shares, and many holders had wished it extinguished, but as most of the large shareholders are able and willing to provide further funds when the appropriate time arrives, the policy of cutting paid and unpaid capital equally was deemed preferable. The company's list of share assets contains many promising ventures; for instance, Mexican Corporation, whose Fresnillo silver mines should be profitable; Ayan Corporation, which owns interesting property in the neighbourhood of the Okhotsk Sea; Bwana M'Kubwa Copper, in Northern Rhodesia; British Equatorial Oil Co., whose properties in Venezuela have recently been examined by Dr. Malcolm Maclaren; and the South American Copper Syndicate, whose properties, also in Venezuela, have been examined by Mr. C. H. Stewart. The company also has many shareholdings in the nature of market investments rather than of development interests, such as Burma Corporation, Tanganyika Concessions, and Anglo-American Corporation of South Africa. The eventual outlook is sound enough, and as for the reduction of capital, this, as we have said, is not an uncommon event in the early history of companies of this kind. Central Mining and Consolidated Mines Selection experienced the same apparent disaster, but no one can allege that these companies are not strong and influential nowadays.

At the meeting of the Central Mining and Investment Corporation, Sir Lionel Phillips was able to show that through prudent finance in the favourable years the Corporation had been able to pay a satisfactory dividend for so gloomy a year as 1921. He had much to say with regard to the beneficial effects of the strike and attempted revolution in South Africa, and he anticipated an early return to the economic conditions that prevailed before the war. From an engineer's point of view the most interesting point in his speech was perhaps his reference to the desirability of maintaining a regular monthly output of gold. The consulting engineers of the group, in suggesting methods of reducing costs, have pointed out that the continual transfer of miners and machines from one place to another with the object of treating ore of such varying qualities as to make the desired average for each month is an expensive process, and they recommend that attempts to equalize the monthly returns should be abandoned. Sir Lionel, however, is not prepared to accept this suggestion or to recommend its adoption unless shareholders generally desire it. There are very definite advantages in a regular output, for it maintains the confidence of shareholders and prevents nervous or ill-informed shareholders from being stampeded by outside raiders; it is also a safeguard against a misuse of reserves, and the exaggeration of irregularity of output for the speculative benefit of the unseen hand. Moreover, the suspension of monthly returns entails the disadvantage of enabling the rumour-monger to get to work with even more disastrous results.

Mr. Walter McDermott was not able to give such a good account of affairs to shareholders in Consolidated Mines Selection as Sir Lionel Phillips could to Central Mining shareholders. The adverse circumstances were due to bad luck at West Springs and Daggafontein and to the suspension of operations by the Consolidated Diamond Mines of South-West Africa, owing to the depression in the diamond market. There is nothing inherently wrong with West Springs or Daggafontein, and when more propitious times arise, further capital can be obtained for the purpose of development. As for diamonds, more recent news is to the effect that production is being resumed, a fact which goes to show that the small good-quality stones characteristic of South-West Africa find the readiest market.

Much of Mr. F. A. Govett's speeches at the meetings of the Zinc Corporation and the Lake View Investment Trust was devoted to a consideration of the new Elmore chemical process for extracting lead and silver from complex sulphides by the hydrochloric acid reaction. This process is calculated to

be applicable at the Zinc Corporation's mine and at that of the Burma Corporation, the Lake View company's interest in the process lying through its holdings in the Zinc and Burma Corporations. He announced that the large-size plant built for the Zinc Corporation is to be erected in this country, so that the process can be tested on a practical scale here for the benefit of both corporations. This is a sound policy, and confirms Mr. E. P. Mathewson's view that a process of this nature should not be tried at a far-distant spot like the Northern Shan States.

The foregoing brief extracts from speeches by leaders of the London mining market serve to indicate the present trend of affairs and the general outlook for the future. Though for the moment conditions are dull and movements slow, the prospects are encouraging enough, so that a little patience combined with optimism will work wonders.

William Gowland

Professor Gowland was a metallurgist who endeared himself to his fellows in many different ways. A teacher who knew all his students, a writer who could present his subject logically and succinctly, a sound scientist and practitioner, a profound student of the historic and pre-historic working of metals, an anthropologist and antiquary of no mean order, such was the man who was laid to rest on June 14 at Finchley Cemetery near his old principal, Huxley, and near another great educationist, Sir William Peterson, of McGill. He was born in Sunderland in 1842, and after being in the pharmaceutical business for a brief time, went in his 23rd year to the Royal School of Mines. Here he distinguished himself by winning the Murchison and De La Beche medals, and taking the A.R.S.M. in 1870. For a short time thereafter he was with the Broughton Copper Co., of Manchester, but his great opportunity came when he was invited to Japan to become chemist and metallurgist to the Mint at Osaka. Subsequently he held a similar position at the Japanese Arsenal. This was at the period when Japan was beginning to wish for knowledge from outside, and it is not too much to say that that country owes much to Professor Gowland in the matter of working metals and in extracting them from ores by modern methods. Returning to England in 1889, he joined the Broughton Copper Company once more, but remained only for a couple of years, for his services were in general demand in several directions as a consultant. He became Chief Examiner to the Board of Education and External Examiner to the Royal School of Mines in 1894, and in 1903 he was appointed professor of metallurgy in the Royal School of Mines on the death of Roberts-Austen. In this position he had a powerful influence on the rising generation. His predecessor had been a theorist in science, and personally a seeker after his own advantage rather than a help to his students. Professor Gowland instituted a new system, personally supervising the demonstrations and encouraging the individual students, and making stress on the industrial metallurgical reactions and processes rather than on those of the chemical laboratory, but always being scientific though practical. It was during his tenure of office that plans were laid for the new School of Mines and metallurgical laboratory, and his hand is seen in the nature of the apparatus adopted and the instruction now given at South Kensington. Unfortunately the age limit was applied to him by the educational authorities, and he was retired in 1909, after holding the professorship for only seven years. But the Department was glad of his services four years later on the resignation of his successor, Mr. W. A. Carlyle, and he resumed the duties for a short time until Professor Carpenter was able to take the position. His book on the "Metallurgy of the Common Metals" has proved to be the most useful of all general reviews of current metallurgy, and it bore the impress of its author, the practical scientist. As regards professional honours, it may be mentioned that he was a Fellow of the Royal Society, and that he had served as president of the Institution of Mining and Metallurgy, the Institute of Metals, and the Anthropological Society. As an archæologist he was a great authority on, among other things, ancient burial places, and it was for this reason that he was asked to make the celebrated investigations into Stonehenge twenty years or more ago. Recently for reasons of health Professor Gowland was obliged to live in retirement, but his mind was as keen as ever, and he followed the developments of mining, metallurgy, and his other favourite subjects. Of him it can be said that he was a kindly and earnest man and a true friend.

REVIEW OF MINING

Introductory.—The outlook is slowly but steadily improving. The end of the engineers' lock-out has put life into the manufacturing trades once more, and the iron and steel output is gradually increasing. The Irish position seems more hopeful now that the Provisional Government has tackled the rebels. The Continental position is, however, bad, the further fall in the mark being the latest evidence of this.

Transvaal.—To most people's surprise a number of the mining companies on the Rand have declared dividends for the first half of 1922. Seeing not only that the production of gold was at a standstill for two months, but that the expenditure during that time was considerable, a general suspension of dividends would have been justified. Also the provision of funds for the purchase of ex-enemy shares might be expected to deplete the companies' financial resources. But there is a general feeling of optimism with regard to the future efficiency of labour, and the declaration of dividends reflects this attitude. Some controlling houses have, however, preferred to keep their funds in hand. The accompanying table gives the dividends declared.

	2nd half, 1920.	1st half, 1921.	2nd half, 1921.	1st half, 1922.
	s. d.	s. d.	s. d.	s. d.
Brakpan	6 0	3 0	3 0	—
City Deep	4 0	4 0	3 6	1 6
Consolidated Langlaagte	1 6	1 0	1 6	—
Consolidated Main Reef	1 9	9	1 0	—
Crown Mines (10s.)	5 0	1 0	2 3	6
Ferreira Deep	2 6	1 6	9	—
Geduld	2 0	1 6	2 0	1 3
Geldenhuis Deep	2 6	—	—	—
Government Areas	6 0	5 0	6 0	4 0
Kleinfontein	1 0	—	1 0	—
Knight Central	1 6	—	—	—
Langlaagte Estate	1 6	1 0	1 6	—
Meyer & Charlton	14 0	10 0	10 0	10 0
Modderfontein (10s.)	5 9	4 3	5 0	2 0
Modderfontein B (5s.)	2 6	2 0	2 9	1 6
Modderfontein Deep (5s.)	4 3	3 3	4 3	2 6
New Primrose	1 0	1 0	1 6	—
New Unified	2 0	1 0	1 0	—
Nourse Mines	1 0	6	9	6
Robinson Gold (£5)	2 0	1 0	1 0	—
Rose Deep	3 6	1 6	1 6	1 0
Simmer & Jack	6	—	6	—
Springs Mines	3 0	1 6	1 6	—
Sub-Nigel	1 6	9	1 0	—
Van Ryn	1 6*	1 6*	1 0*	1 0*
Van Ryn Deep	8 0	6 0	6 0	2 0
Village Deep	1 6	9	1 3	—
Witwatersrand Gold	3 0	2 0	3 0	1 0
Witwatersrand Deep	—	1 0	—	1 0
Wolhuter	1 3	9	9	—

* [illegible]

Rhodesia.—The output of gold during May was reported at 53,920 oz., as compared with 54,318 oz. in April and 48,744 oz. in May, 1921. Other outputs of Southern Rhodesia during May were: Silver, 15,717 oz.; coal, 37,821 tons; chrome ore, 5,503 tons; copper, 289 tons; asbestos, 828 tons; arsenic, 59 tons; mica, 8 tons; diamonds, 16 carats.

At the Shamva mines the ore developed during 1921 was of lower grade, and the amount added to reserve was 1,415,272 tons averaging 2·5 dwt. gold per ton. The total reserve at December 31, 1920, was 1,981,250 tons averaging 4·1 dwt., and the figure at the end of 1921 was calculated at 2,801,022 tons averaging 3·5 dwt. During the year 595,500 tons averaging 3·36 dwt. was sent to the mill, where 87,115 oz. of gold was extracted. This gold sold for £457,087, and the net profit was £155,106. The balance in hand at the beginning of the year was £110,871, and £180,000 was distributed as dividends, being at the rate of 30%. The working cost per ton was 10s. 2d. Mr. Cyril E. Parsons, the consulting engineer, gives details of the development during the year. He shows that Shamva is a low-grade mine of vast dimensions, and that with the improved conditions now ruling very large amounts of ore of lower grade can be worked at a profit.

At the Falcon mines the auxiliary shaft sunk below the 12th level has passed through the lode, which averages 1¼% copper, 5 dwt. gold, and 9 dwt. silver over 65 in. exposed. Whether or not ore of sufficient quantity and value will be found on the 14th level, which is the present objective, remains to be seen, but in view of the recent disappointments in depth the discovery now recorded is at any rate encouraging.

It will be remembered that dissentient shareholders led by Mr. Stanley Edwards wrested the control of the Gaika Gold Mining Co. from the Gold Fields Rhodesian Development Co. toward the end of last year, and that Mr. A. M. Mackilligin was subsequently sent out to make an examination of the property. Extracts from his report have now been issued, and his views appear to coincide fairly well with those of Mr. Cyril Parsons, the consulting engineer to the Gold Fields group. The ore occurrences are irregular, and estimates of reserves are difficult to make. He recommends that development should be extended at an extra cost of £12,000 spread over twelve months. He also recommends improvements in the

hoisting capacity at the north shaft, and the provision of an electric winder.

West Africa.—The Ashanti Goldfields Corporation announces that the wet crushing plant was completed at the middle of May, and that it is now treating ore at the rate of 7,000 tons per month. Particulars relating to the change of metallurgical treatment were given in our issue of January last.

Particulars relating to the results at Prestea Block A during 1921 are given elsewhere in this issue. In order to keep development going in face of losses it has been necessary to reconstruct once more. The capital is to be reduced by writing the shares down from £1 to 4s., and at the same time 3,750 of the unissued shares are to be converted into 75,000 B shares. Debentures to the extent of £50,000 are to be issued, and holders will have the right to subscribe to these B shares at par. The B shares will be entitled to one-third of the profits, and in a winding up to one-third of the assets. Mr. S. H. Ford writes hopefully of the developments now in hand on the new orebody recently discovered in depth. It is noteworthy that the costs per ton have been reduced from 50s. to 39s. since January last; credit for this improvement is to be given to Mr. Ford and to Mr. C. E. Jobling, the new manager. As regards subscribers to the debentures, it is of interest to record that Minerals Separation is included in the list, which means that the troublesome graphitic ore is to be treated by flotation.

Portuguese East Africa.—The Trans-Zambesia railway was opened on July 1. This railway connects Beira with Murassa on the south side of the Zambesi. On the opposite side of the Zambesi is Chindio, the starting point of the Nyasa railway, which runs northward to Blantyre. This new line will be of great help in the commercial development of Nyasaland. A bridge is to be built at some time in the future across the Zambesi, and there are plans for a branch line from the Nyasa railway to Lake Nyasa.

Australia.—At the meeting of the Great Boulder Proprietary, Mr. John Waddington, under whose auspices the company was formed 28 years ago, gave some particulars of the history of the venture. Mr. Waddington acquired the Great Boulder mine from the Coolgardie Gold Mining and Prospecting Co., of Adelaide, of which Mr. (now Sir) George Doolette was chairman, and he floated it in London in 1894 as the Great Boulder Proprietary Gold Mines, Ltd., with a capital of £175,000 in £1 shares. The public, however, did not respond and the underwriters were saddled with 90% of their guarantee. In those days the results of development were poor and the pound shares sagged to 5s. Then came the discovery of the rich lode, and the shares bounded to £20. The shares were split into ten of 2s. each in 1897, and even now, with the end of the mine in sight, these 2s. shares stand at 5s. From the commencement of operations until the end of 1921 3,536,882 oz. of gold has been extracted from 3,364,642 long tons of ore, and £5,925,550 has been distributed as dividends. In his speech to shareholders Mr. Waddington referred regretfully to the fact that he and Sir George Doolette are the only survivors of those connected with the mine in the earliest days. Of the original board of directors, Messrs. Gamble North, G. M. Inglis, A. Robertson, David Murray, and himself, only he survives. The original advisory board in Australia consisted of Sir George Shenton, Mr. H. W. Venn, and Mr. (now Sir) George Doolette. The two former have passed away; the latter joined the London board in 1894, and was elected chairman in 1902. Two other directors elected in 1898 are also dead, as are the first two secretaries, and Mr. Zebina Lane, the first manager. The first list of shareholders contained 135 names, and of these thirteen are still on the register. At the present time there are 7,500 shareholders, of whom 4,500 are in England and 3,000 in Australia. It ought also to be mentioned that Mr. Richard Hamilton, who succeeded Mr. Zebina Lane, has been manager for over 25 years. We may be permitted to express the hope that the shareholders will continue to have the advantage of the advice and direction of Sir George Doolette and Mr. Waddington, and of the management of Mr. Hamilton, throughout the life of the mine.

Oroya Links reports that the treatment plant purchased from the Kalgurli company is now ready to start operations, and that the old Oroya Brownhill plant was shut down on June 1.

Papua.—Shares of the New Guinea Copper Mines, Ltd., incorporated in Victoria, have been introduced on the London market, and particulars of the properties have been published. The directors are all Broken Hill men. Mr. G. C. Klug is on the board, and Mr. Erle Huntley is manager. The company

was formed to take over the property of the Laloki (Papua) Copper Mines Co., and to provide further funds. The properties are situated near Sapphire Creek, not far from Port Moresby, the capital of Papua. The ore developed down to the 200 ft. level on the Laloki and Dubuna mines is estimated at 300,000 tons, averaging 4·8 to 5% copper, 42% sulphur, 2½ dwt. gold, and 10 dwt. silver. The lode has been cut at 100 ft. below the 200 ft. level, and here the ore averages 7% copper. Development on outcrops on the same line of lode indicate the existence of other valuable ore-bodies. The pyritic nature of the ore makes it suitable for the sulphuric acid manufacturer, and contracts have been let on this basis. The company is also erecting a smelting plant which will have an output of 300 tons of blister copper per month.

New Zealand.—As recently recorded, Mr. P. G. Morgan, Director of the Geological Survey, has been examining the Waihi gold mine. The cable message dealing with his report is too brief for discussion. It is gathered that he recommends prospecting to 2,000 ft., which is about 600 ft. below the present level; also that he considers the discovery of an enriched zone below as probable. He also recommends general lateral exploration.

India.—For some time it has been known that the Cape Copper Company was in financial difficulties in connexion with its Rakha Hills mine, in Chota Nagpur. Last month the debenture holders applied to the High Court in London for the appointment of receivers.

The Tata Iron and Steel Company is issuing £2,000,000 debentures for the purpose of providing funds for the general expansion of the business, so that the company shall be able to cope with the increasing demand for its iron and steel products. Particulars of this enterprise were given in our issue of June and July, 1921.

Burma.—Like most of the oil companies the Burmah Oil Co. shows a decrease in profits for 1921 owing to the fall in prices of the market products. The gross profit for the year was £3,357,500, as compared with £5,096,000 for 1920. The allowance for depreciation was £1,247,700, and £220,000 was placed to reserve. The preference dividend absorbs £162,000, and the ordinary dividend £1,543,000. The company, however, does not have to pay any excess profits duty this year, as against a payment of £1,900,000 last year, so it happens that the ordinary dividend at 30% is the same as that for 1921.

Canada.—The shareholders of the Associated Gold Mines of West Australia have agreed to a scheme of reduction of capital and a partial distribution of assets. For some years the mine at Kalgoorlie has been showing signs of exhaustion, and the future of the company is in Ontario, where it has interests in the Keeley silver mine, near Cobalt, and in the North Thompson gold mine at Porcupine. The £1 shares are to be reduced to 10s., of which 9s. will be represented by cancellation of capital, and 1s. by the distribution of 99,073 dollar shares in the Canadian company formed to acquire the Keeley property, this being five-eighths of the Associated holding in Keeley. The company has also arranged with the Huronian Belt Company, which originally took steps to inquire into Ontario properties, to cancel its right to participate in business, by the issue of 100,000 Associated shares to the Huronian Company. As recorded last month the operations at Keeley are likely to be substantially expanded now that the company has been given Canadian domicile. As regards the North Thompson, this was reopened a month or two ago, and development is now proceeding.

Colombia.—The life of the Nechi company's property is estimated at two years, but Mr. W. A. Prichard, the manager, proposes that certain other areas should be treated by the dredge. As the treatment of these areas is considered risky owing to the proximity to the river, and the dredge might be lost during flood, it is now proposed that Oroville Dredging, the parent company of the Nechi and Pato companies, shall issue Oroville shares to holders of Nechi preference shares at the rate of two Orovilles to seven Nechi preference. The Nechi shareholders thus become members of a company which is assured of a long life and has excellent prospects for future business. The Nechi dredge will operate Pato ground before being put on the dangerous ground.

South Georgia. — The mineralogist accompanying the *Quest* expedition reports that diamondiferous ground exists on an island of the South Georgia group, east of Cape Horn. It is stated that representatives of a Cape Town fishing company have tested this ground and have found diamonds. A further expedition is to be undertaken by the company.

PETROLEUM IN CENTRAL AMERICA AND THE WEST INDIES

By HENRY B. MILNER, M.A., D.I.C., F.G.S., A.M.I.P.T.,
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In this article the author describes the petroleum indications and developments of Central America and the more important islands of the West Indian Archipelago, excluding Trinidad. Geological knowledge of these remnants of the ancient Antillean continent is recapitulated and brought up to date with a view to indicating from the scientific standpoint favourable and unfavourable prospects for future oil-land development.

Although geographically distinct units, Central America and the West Indian Archipelago are but remnants of a very ancient continent, once occupying a vast area, now largely depressed beneath the Caribbean Sea and the Gulf of Mexico. The original limits of this continent, known to palæogeographers as "Antillia," are impossible of precise definition, though there is reason to believe that it was considerably larger than present-day evidence indicates, particularly in its eastward extension, while at the time of its existence as dry land much of the central part of the North American and South American continents was submerged. It follows from this that we recognize in Central America and the West Indian Islands a region fundamentally distinct from those two continents, possessing certain geological characteristics which stamp its independence as a tectonic province.

The trend of predominant mountain ranges is frequently a clue to the major direction of regional folding in any country, and this is certainly true in the present case. It is important to notice the parallelism of the mountain lines of Central America with those of the Greater Antilles and North Venezuela; in all cases a dominant tendency to an E.–W. strike is observed, a direction quite oblique to the lines of folding evidenced by the Rocky Mountains and the Andes of North and South America respectively. This E.–W. trend may be specifically noted in the Sierra de las Minas and the Cockscomb Mountains of Southern Mexico, in the Montanas de Piji of Honduras, in the Sierra de Chiriqui and Sierra de Veraqua of Panama, in the Sierra Maestra of Cuba, in the uplands of Haiti, Santo Domingo, Porto Rico, and Trinidad, and in the coastal cordillera of Venezuela. Added to this, a pronounced E.–W. strike of the volcanic lines in Central America and the Greater Antilles is significant, while the great depths recorded by the hydrographic charts of the Caribbean Sea reveal themselves in the form of elongated troughs over 15,000 ft. deep and extending in a similar direction, for instance, Bartlett Deep between Jamaica and the Cayman Islands.

From these comparatively slender shreds of physiographical and hydrographical evidence, it is possible to reconstruct with a fair degree of accuracy the structural characteristics of this Antillean continent, of which a clear idea is essential to any intelligent discussion of the geology and hence petroleum potentialities of the region as a whole. Were this sunken area to be raised completely above sea-level, the configuration of the continent would reveal a remarkably diversified topography, of which the principal feature would be that of a compound mountain chain encircling a basin-shaped area, more or less shut in to the east (Lesser Antilles), though breached by a few broad valleys to the west, the latter aspect complicated by numerous small mountain ranges of Central America which strike rather obliquely to the main lines of uplift of that region. The central part of the basin itself (Caribbean Sea) would be found to present the features of an undulating plateau, broken by long though narrow valleys of great depth (? rift valleys), of which the Bartlett Deep is an instance. The compound mountain chain would in its eastern disposition figure as three concentric ranges, corresponding to the three Antillean zones as defined by Suess.[1] The flattening out of the fold arc in an E.–W. direction would delineate the principal uplift masses, whose summits are now represented by the Greater Antilles and the elevations of Northern Venezuela, subsidiary ranges in North-West Haiti and Cuba being also manifest. Thus continuity with existing ranges of Central America would be shown.

It is necessary to examine these structural features in some detail, as the three concentric zones referred to above show certain fundamental differences in geological character.

[1] Suess, *La Face de la Terre*, Tome i, 1900, ch. x, pp. 724–37. See also F. R. C. Reed, *Geology of the British Empire*, 1921, ch. ix, and references there cited.

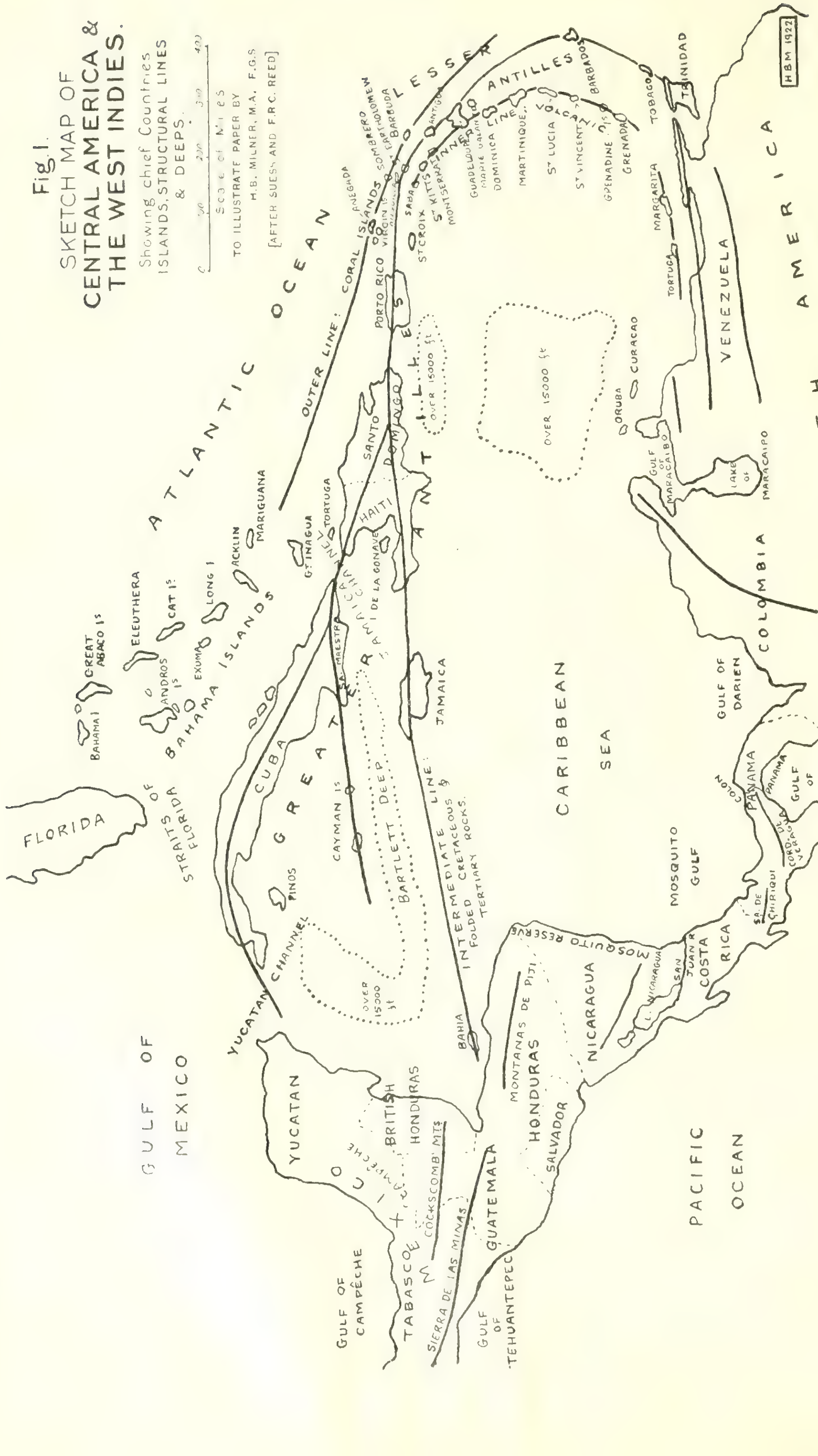


Fig. 1. SKETCH MAP OF CENTRAL AMERICA & THE WEST INDIES. Showing chief Countries, Islands, Structural Lines & Deeps.

The innermost zone (Fig. 1) comprises the islands of Saba, St. Eustace, St. Kitts, Nevis, Redonda, Montserrat, Western Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Bequia, the Grenadines and Grenada, mentioned in geographical order from north to south.

The intermediate zone constitutes essentially the Greater Antilles and several of the more important of the Lesser Antilles ; it corresponds to the most persistent orogenic line of all, having, in addition, two subordinate branches to the north-west (Fig. 1). Doubtless connected with the mountain ranges of Central America, more particularly the Montanas de Piji of Honduras, the line is traceable from Bahia, off the coast of the latter country, through Jamaica, the southern part of Haiti and Santo Domingo to Porto Rico, the Virgin Islands (comprising Culebra, St. John, St. Thomas, and Tortola), St. Croix, Anguilla, St. Bartholomew, Antigua, Eastern Guadeloupe, Marie Galante, Western Barbados, Tobago, Trinidad, and Northern Venezuela. The two subordinate lines of uplift include the mountains of Northern Haiti and Santo Domingo, the Sierra Maestra of Southern Cuba, and the Cayman Islands on the one hand, with the central uplands of Cuba on the other. The third or outer zone embraces the Bahama Islands, Anegada, Sombrero, Barbuda, and probably South-Eastern Barbados.

As indicated, the three zones are geologically quite distinct. The innermost zone is essentially volcanic, the prevalent rock types developed being andesitic lavas of Tertiary age. The intermediate zone involves principally Cretaceous and Tertiary rocks, in many instances intensely folded. The outer zone comprises almost entirely coral islands of comparatively recent age.

Turning to the Central American States, we find that the geology of Southern Mexico, Guatemala, Salvador, British Honduras, Honduras, Nicaragua, Costa Rica, and Panama presents certain features common to all, such as the extensive development of Cretaceous and Tertiary deposits breached and overlain by volcanic rocks. Broadly speaking, the character of this isthmus is that of a great limestone plateau, ranging from 2,000 to 4,000 ft. above sea-level, broken in many places by lofty volcanic mountain ranges whose peaks frequently rise to a height of 11,000 ft., and also by folded limestone uplifts. This plateau terminates in steep scarps both to the west and to the east, in the latter respect possessing a gentler slope to the coastal plain than on the Pacific side, where the plain is almost non-existent and the slope frequently abrupt to the sea. Further, in Nicaragua, Costa Rica, and Panama, the intricate association of both volcanic mountains and folded limestone ranges, together with the deep depressional rifts often separating the latter, give rise to a more varied physiography than in the northern states ; this is especially illustrated by the depression in which Lake Nicaragua and its easterly draining river, the San Juan, are situated, bordered on the N.E. by the Cordillera de Yolaina and on the south by the 4,000 ft. plateau of northern Costa Rica.

The contrast between the Caribbean and Pacific margins of Central America is at once a reflection of the geological difference manifest in the eastern and western borders of the states concerned. Apart from the prevalent E.-W. direction of folding already alluded to, there is a tendency for these lines of uplift to swing round to a N.W. direction as they approach the Pacific basin. This feature may be noted in the Sierra de las Minas of southern Mexico, in the Sierra Madre of Guatemala, and in the mountains of Salvador, Nicaragua, and Costa Rica, and it not only determines the trend of the coast-line itself, but by reason of the steepness of the Pacific side of the folds, it forbids the existence of a broad coastal plain comparable with that bordering the Caribbean Sea. The close proximity of the mountain ranges to the Pacific coast thus results in many cases in a sharp rise from sea-level to an average elevation of 7,000 to 8,000 ft. These coastal ranges are in nearly every case volcanic, and in a country like Salvador, for instance, form the major geological, hence physiographical, features.

It should be apparent from the above remarks that there are certain portions of Central America and the West Indies that can be logically eliminated at the outset from any discussion of their oil potentialities, partly from a consideration of the character of the rocks involved and partly from adverse tectonic factors, deducible from a careful study of the geographical evolution of the region as a whole. These unsuitable areas include practically the whole Pacific borderland and much of the interior of the States of Guatemala, Salvador, Nicaragua, Costa Rica, and Panama (actually the entire country of Salvador itself), also the islands belonging to the inner zone of folding and

those comprising the outer zone (Bahamas, etc.).

It would seem scarcely necessary to have to draw attention to the fact that regions of great volcanic manifestation are unsuited to the occurrence of petroleum, just as intensely fractured structures, such as are met with in many parts of Central America, are alike unfavourable. But one hears of so many instances of oil exploration in such regions that it is relevant to emphasize the point, though we can well understand any adherent to the inorganic (volcanic) theory of the origin of petroleum advocating such adventures, more especially since the association of oil with sediments invaded by igneous rocks in eastern Mexico is a case so well known and so often quoted. In the latter connexion, confusion of cause and effect has resulted in misinterpretation of the phenomena observed, whereby evidence in support of the inorganic theory has been adduced. Conditions of occurrence of petroleum in Mexico are to no degree anomalous, if we consider the oil to be indigenous to the sediments wherein it occurs, though influenced in its local migration and accumulation by mechanical factors involved by widespread igneous activity. We purposely stress this point for obvious reasons, though space does not permit a fuller explanation here.

Omitting consideration of the fundamentally unfavourable areas then, for present purposes we have to concentrate on the Caribbean borderland of the several Central American States, and those West Indian islands situate on the intermediate fold arc and its E.–W. extensions. In order to complete the descriptions, the islands fringeing the north coast of South America (being tectonically part of the region under discussion) are included, Trinidad and the countries of Venezuela and Colombia being omitted in view of their detailed treatment in previous articles by the writer.[2] It is convenient to take the Central American prospects first.

SOUTHERN MEXICO.—We are not here concerned with the chief Mexican oilfields as such, these being located in the coastal states of Tamaulipas and northern Vera Cruz, and therefore extraneous to the region embraced by this paper. Attention is directed to the southern states, more particularly those of Tabasco, Campêche, and the Yucatan territory. Much of this country is geologically unexplored, but Cretaceous and Tertiary rocks are in evidence on the northern side of the central mountain divide, the latter composed of volcanic rocks.

The coastal plain, especially in Tabasco, is made up of Pleistocene and recent deposits, much of the country being practically impenetrable swamp. Oilfield development has made somewhat slow progress, operations in the past being hampered largely by adverse political conditions, being also to a great extent eclipsed by the wonderful strides made in the Tampico-Tuxpam region farther north. In this southern district, known also as the Tehuantepec region, fields have been opened up at Ixhuatlan, Tecuanapa Soledad, San Cristobal, La Reforma, and Pichicalco, chiefly the result of British enterprise. The oil is associated with Pliocene sands and salt deposits (saline domes), structural conditions resembling those of the Gulf Cretaceous field of the United States, though of a more disturbed character. There is a refinery at Minatitlan capable of handling 10,000 barrels of oil per day. The oil varies in grade considerably from well to well, being for the most part of mixed base, and of specific gravity from 0·792 to 0·881.

Because of political disturbances, operations practically ceased in southern Mexico in 1917, when the output only amounted to 23,556 barrels for that year. Exploration in the State of Campêche and in Yucatan was also impeded, but is reported to have been resumed. The prospects in both these areas are favourable.[3]

GUATEMALA.—Cretaceous and Tertiary rocks occupy a large part of central and northern Guatemala, geologically a continuation of the same belt in southern Mexico. Much of the southern region of the State, including Guatemala City, rests on volcanic rocks, while locally a tract of Carboniferous sediments stretches with an E.–W. strike from Lake Izabal (S.W. of Puerto Barrios on the east coast) to Totonicapan in the west. The Tertiary rocks are alleged to contain oil, indications being reported from the districts of Huehuetenango, Quiche, Coban (Vera Paz), and from the region of Lake Izabal. A strong anticlinal brings up Cretaceous beds in the middle of the Tertiaries in northern Guatemala, the same fold continuing eastwards into British Honduras, where it is

[2] "The Oil Resources of South America": MINING MAGAZINE, April, 1921. "Trinidad," etc.: MINING MAGAZINE, October and November, 1921.

[3] See Sapper, *Journ. Geol.* (Chicago), iv, 1896, pp. 938–47.

Fig. 2.
CENTRAL AMERICA.
Showing Petroliferous Areas at present known [thus] and chief localities mentioned

[To illustrate paper by H. B. Milner, M.A. F.G.S.]

involved with the structures associated with the Cockscomb Mountain horst, the latter including Palæozoic sediments and igneous rocks. Prospects in this northern part of Guatemala would seem to be at least structurally favourable, though there is little information obtainable as to petroleum indications in the region.[4]

British Honduras.—The principal physiographical and geological feature of this country is the Cockscomb Mountains, situated to the south and rising to a height of over 4,000 ft. above sea-level. Having a pronounced E.-W. strike, the range involves both igneous rocks and limestones, the latter of late Palæozoic age; it is in the nature of a horst, bounded by strike faults and much cut up by transverse faults in several places. The ridge is flanked to the south by a narrow belt of Cretaceous rocks consisting principally of limestone and dolomite, the latter strongly bituminous. The coastal plain varies from 30 to 40 miles wide, and is composed of Pleistocene deposits overlying rocks of Miocene and Pliocene age, most strongly developed north of the Cockscomb Mountains. Eocene marls and limestones occupy a small area in the south-eastern part of the country, almost bordering Amatique Bay. The chief town is Belize on the coast, from which centre geological explorations have been frequently made in the past, particularly for gold; oil exploration has been largely confined to the Cretaceous dolomite region, and to the northern area of Tertiaries, though a more thorough geological survey is now in progress. Geologically speaking, the conditions would seem to be decidedly favourable to the ultimate location of an oilfield in this country.

Honduras.—Parts of the Republic of Honduras remain geologically unexplored at the present time, but very favourable indications of petroleum are reported from several districts, notably from the limestone mountains of Guare, near Comayagua, some 60 miles south of Puerto Cortez. Seepages of oil are known at many points along the Caribbean coast-line, from the mouth of the River Ulua to Truxillo and beyond, north of

[4] Sapper, *Petermann's Geograph. Mitteilungen*, xxvii, No. 127, 1904, pp. 1–119.

the Piji range. Much of the western part of the State is composed of volcanic rocks (continuous from the highlands of Salvador) fringed by a narrow belt of Cretaceous limestones to the north. In the neighbourhood of Tegucigalpa, Jurassic and older Palæozoic rocks have been described. The structures are from all accounts somewhat complex where the rocks have been studied, the predominant strike of the rocks and of the folds being E.-W.

NICARAGUA.—This country is to all intents and purposes *terra incognita* as regards its detailed geology. Practically its whole eastern borderland—which might well be favourable from the standpoint of oil resources—is included in the uninviting territory of Mosquitia, a fever-stricken swamp some 400 miles long, extending northwards into Honduras. One or two surveys have been carried out in this region, notably along the Rivers Grande and Prinzapolca, but the results were not encouraging. An important physiographical feature is that of Lake Nicaragua with its easterly draining river, the San Juan ; along this valley a tract of Miocene and Pliocene rocks exists, flanked on either side by igneous rocks ; this belt yields evidence of oil, but not such as to invite large-scale development.

COSTA RICA.—Save for a central volcanic belt, some Tertiary deposits in the extreme north-west of the republic, and an ill-defined Cretaceous-Tertiary tract of country in the south (north of Puerto Arenitos), our knowledge of the geology of Costa Rica is very incomplete. The Caribbean coastal plain would seem to offer favourable petroleum prospects, and recently indications have been reported from the Puerto Limon district. The geographical trend of the country is W.N.W.-E.S.E., this being the principal strike direction of the rocks alluded to above. Political conditions have done much to hamper development of the oil resources of this country, especially by foreign interests, but the granting of concessions in the north to a British company and in the south to an American company, is significant of progress, although no reports have as yet appeared concerning the respective operations.

PANAMA.—Exploration for oil has been largely confined in this country to the province of Chiriqui, wherein some likely Tertiary deposits outcrop. The most favourable areas lie in the extreme western part of the state, with possibilities in the Cretaceous rocks of the Azuero peninsula. East of the Panama Canal, practically nothing is known of the geology until Colombian territory is reached, where the Miocene rocks bordering the Gulf of Uraba are petroliferous, these extending into Panama itself. The geographical trend of Panama is E.-W., and the structural features, as illustrated by the Sierra de Chiriqui and the Sierra de Veraqua, conform to this direction.

WEST INDIAN ISLANDS.—Attention is next directed to those of the West Indian Islands situated on the intermediate structural line (with its subsidiary branches) as previously described. Reference to the map (Fig. 1) will show that some comparatively large islands are comprised within this group, especially Cuba, Haiti, and Jamaica. It will be convenient to discuss these geographically from west to east, following the trend of the fold-arc. Fortunately considerably more is known of the detailed geology of these islands than in the case of Central America, so that forecasting achieves a correspondingly greater degree of accuracy.

CUBA.—The geological structure of Cuba is essentially anticlinal, the exposed core of the fold composing the undulating hilly region forming the backbone of the island. This core is mainly igneous, though with associated metamorphic rocks and altered limestones, probably of Palæozoic age or older. These are surrounded by younger rocks which have been stratigraphically subdivided as follows :

(6) *Recent.*	Coral limestones, sands, and soils.
(5) *Quaternary.*	Gravels and sands.
(4) *Tertiary.*	Sedimentary and igneous rocks (in part).
(3) *Cretaceous.*	Sands, shales, conglomerates, and limestone, with serpentine probably referable to this horizon.
(2) *Jurassic* and *Triassic* Limestones.	
(1) *Palæozoic.*	Igneous and Metamorphic rocks (basement complex).

The Jurassic and older rocks have apparently been intensely folded, in contrast with the Cretaceous and Tertiary deposits which rest on them unconformably as a gently tilted series. The latter rocks are, however, involved in subordinate flexuring and are pierced by igneous intrusives.

Many surface indications of petroleum are manifest in the island, the chief being asphalt and oil seepages, in some cases accompanied by much gas. These indications, though reported from nearly every part of the island, are most favourable along the north coast, within a narrow tract of country about 20

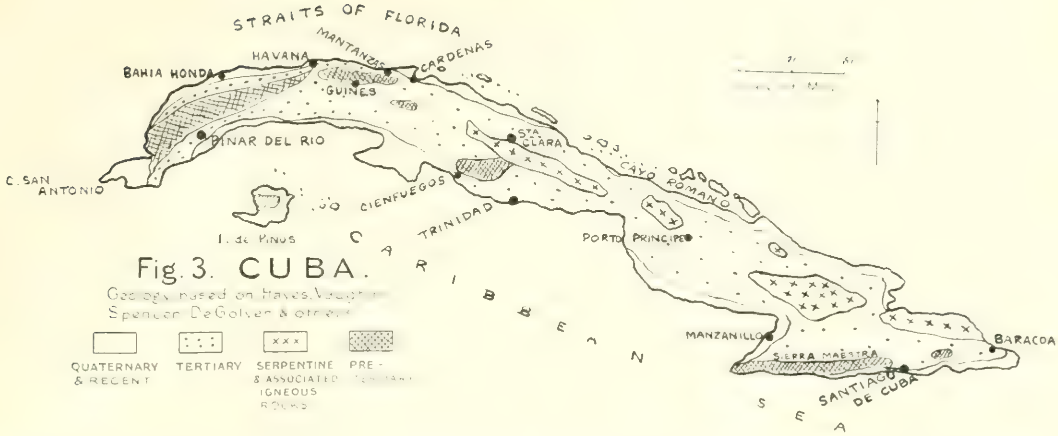


Fig. 3. CUBA.

miles wide, stretching from Cape San Antonio to the eastern border of the province of Santa Clara, a distance of some 500 miles. (Fig. 3.) Some trial wells have been drilled within this belt, but no great supply of oil has been forthcoming. A well put down at Motembo in Santa Clara province and belonging to the Cuban American Sugar Company, attained a depth of nearly 2,000 ft., and yielded about 10 gallons of a high-grade oil per day, s.g. 0·702. There are some shallower wells in the same district, down to 700 ft., while one at Cardenas, to the west, has given a total output of 100,000 gallons to 1921. The Cardenas district has been the scene of recent activity, wells ranging from 1,000 ft. to 2,400 ft. in depth having been drilled. In most cases where oil was struck, it was found in association with fractured serpentine intruded into limestone. The origin of the oil is doubtful, but it would seem to be derived from some of the older Mesozoic sediments, reaching its present position by upward migration, taking advantage of the fissuring of the Cretaceous deposits as a result of igneous activity.[5]

While the prospects of the island are on the whole favourable from the standpoint of commercial development, it is unlikely that any large field will be located, mainly owing to widespread igneous manifestation. The present production is quite insufficient to meet industrial demands, and in the absence of coal resources, large imports of oil-fuel are made annually.

There are in Cuba several deposits of native asphalt, some of remarkable purity, as, for example, that occurring in the Santa Catalina district in the Province of Mantanzas. This asphalt is in a semi-liquid state and oozes from joints in serpentine at the rate of about 20 barrels per day. Somewhat impurer types of asphalt are mined in the same province at the bottom of Cardenas Harbour (Constancia Mine), and other deposits have been located to the east of this town. The Angelo Elmira Mine, Bejucal, south of Havana, yields a moderately pure bitumen, while typical grahamite (a variety of asphaltite) has been mined in the district of Mariel, Pinar del Rio Province, in Campo Florido, Province of Havana, and in Loma Cruz, Santa Clara Province. In all cases the product is associated with serpentinous rocks.[6]

Cayman Islands.—These comprise both the Grand and Little Cayman Islands, situated on the western continuation of the fold-arc forming the Sierra Maestra of southern Cuba (Fig. 1.) We have practically no geological knowledge of these islands, beyond the fact that recent coral figures largely in their making, this surrounding a nucleus of older rock comparable to that forming the core of the mountain range above mentioned. Fundamentally there is neither reason for nor against the possibility of petroliferous deposits occurring in these islands, though no reports concerning prospects have thus far appeared.

Jamaica.—In his descriptive article in

[5] See De Golyer, "Geology of Cuban Petroleum Deposits": *Am. Assoc. Petroleum Geologists, Bull.*, vol. ii, pp. 133–67, 1917; also Vaughan, "Bitumen in Cuba": *Eng. & Min. Journ.*, vol. lxxiii, p. 344, 1902; Peckham, "Bituminous Deposits of Cuba": *Am. Journ. Sci.*, ser. iv, vol. xii, pp. 33-41, 1901; Arnold, *Econ. Geol.*, vol. ii, pp. 301–2, 1916; and Hayes, Vaughan & Spencer, Report on a Geological Reconnaissance of Cuba, Washington, 1901.

[6] See Vaughan and Peckham, op. cit.; also Abraham, *Asphalts and Allied Substances*, 1918.

the April number of the MAGAZINE, Sir Stopford Brunton writes as follows: "So far, neither petroleum not natural gas has been found in Jamaica, but during the winter of 1919–20 some prospecting was done with a view to determining the possibilities of finding oil in certain western parishes." It seems almost incredible that the largest of the British West Indian Islands should have been neglected in the matter of oil exploration until comparatively recently, but such appears to be the case.

The geology of the island has been studied by several workers, and a good deal more information is available than is given in Sawkins' "Reports on the Geology of Jamaica", published in 1869, on which Sir Stopford Brunton bases his facts.[7] Broadly speaking there are four definite series of rocks corresponding to the four marked physiographical features of the island:—

(4) *Lower Miocene—Recent.*	Coastal Series. Developed in coastal plains.
(3) *Post Oligocene.*	Igneous Intrusives. Intruded into older beds.
(2) *Oligocene.*	Oceanic Series. Forms limestone plateau rising to 3,000 ft.
(1) *Cretaceous-Eocene.*	Blue Mountain Series. Forms interior uplands rising to 7,000 ft.

There are two definite directions of folding visible in the island, an ancient N.W.-S.E. trend intersected by a later E.-W. series of folds; on this account the structures in places assume great complexity, though, as the writer has shown elsewhere,[8] such structures are frequently favourable to the accumulation of petroleum, providing the faulting has not been too excessive. In Jamaica, however, there is apparently very little surface evidence of oil, though the nature of some of the deposits, more particularly the lowest members of the Coastal Series, is suggestive. Apart from the western part of the island, some possibilities would seem to exist in the district lying to the east of Kingston, where both sediments and structures are potentially favourable.

[7] See particularly Hill, "Geology of Jamaica": *Bull. Mus. Comp. Zool., Harvard*, xxxiv, 1899, pp. 1–256; Dall, *Trans. Wagner Instit.*, iii, 1892, p. 1580; Guppy & Dall, *Proc. U.S. Nat. Hist. Mus.*, xix, 1896, pp. 303–30; and F. R. C. Reed, *Geol. Brit. Empire*, 1921, pp. 172–5 and map, p. 188.

[8] MINING MAGAZINE, April, 1921.

HAITI AND SANTO DOMINGO.—The configuration of this island is primarily determined by the two tectonic lines which bifurcate approximately at San Juan (see Fig. 1). The northern line of uplift does not apparently give rise to quite the same type of structure as that met with in its westerly prolongation in Cuba, nor does it involve the strongly bituminous deposits which constitute such a feature of that island. It is essentially the southern structure line which is the important one in this case, though it is not until the beds are traced well into the Republic of Santo Domingo that evidences of oil are manifest. The chief locality is 3 miles north of Azua, a town on the coast, some 15 miles west of Santo Domingo itself. The oil first showed in shallow pits dug for water, and later in the dry season, along stream beds. It is probably derived from Cretaceous-Eocene beds of the same character as the Oceanic Series of Jamaica, with which island Haiti has direct structural relationship. A test-well put down near Azua has yielded a commercial supply of a heavy asphaltic oil, rather sulphurous, and of s.g. 0·934. The latest information goes to show that an American company contemplates some deep tests in this district, and, if successful, the results should have a decided bearing on the petroleum possibilities of south-eastern Jamaica, for reasons above given. The glance pitch deposit, reported from the Bay of Ocoa, has apparently not yet been developed.

PORTO RICO.—Little is known of the geology of this island beyond the fact that its structure is broadly anticlinal and that the folds involve bituminous deposits of Tertiary age. Indications of petroleum occur at many points along the south coast, more particularly in the south-west corner, between San German and Punta Aguila.

Tracing this intermediate fold-arc further east, we come next to a group of much smaller islands, comprising the VIRGIN IS., ST. CROIX, ANGUILLA, ST. BARTHOLOMEW, and a number of minor and in many cases uninhabited tropical islets. In some of the larger members of this group, both Cretaceous and Tertiary rocks have been located, but the geology is frequently complicated by the presence of igneous material, principally granites and diorites. No oil indications have been reported from these islands, and, geologically speaking, it is doubtful whether the prospects are favourable. Arguing on analogy with other areas throughout the

world, where the trend of a fold-arc is suddenly deflected, consequent on a change in the configuration of the horst or resistent mass of rock against which the sediments are folded, the region becomes locally unfavourable to oil accumulation, since the stress under which the rocks achieve their ultimate disposition is too great to permit of structural stability; at such places the rocks are often intensely overthrust and fractured, and it is not until the curve flattens that conditions are such as to promote concentration of any oil present in the sediments involved in the movements. In the present case, this group of islands are situated just where this important structural line changes its direction from west by east to south (Fig. 1), and it is not until we reach Antigua, therefore, that prospects become potentially more hopeful.

ANTIGUA.—Practically the entire southern and western parts of this island are composed of a complex of igneous rocks and altered sediments corresponding in age and character to the Blue Mountain Series of Jamaica.[9] There remain the Tertiary areas of the central plain and of the country to the north and north-east which have been prospected, but so far no favourable indications of petroleum have been reported, though the type of rocks developed in the north-east (representatives of the Oceanic Series of Jamaica) and also the local structures, would seem to be quite favourable.

GUADELOUPE.—Reference to the map (Fig. 1) will show that this island is related to both the inner and the intermediate fold arcs, the former determining the character of the western part and the latter that of the eastern part of the island. Accordingly the geology is well differentiated both as regards structure and the rocks engendered, volcanic rocks forming the chief feature of Western Guadeloupe, while Tertiary sediments, alleged to be favourable from the standpoint of petroleum, are present in the east. Comparatively little detailed geological information of this island is available, however.

BARBADOS.—This island has long been known as the source of "Manjak", an exceptionally pure variety of glance pitch which occurs in several localities, notably at Burnt Hill, Conset, Groves, Quinty, St. Margaret, and Springfield. The deposit occurs as dykes and veins associated with sandstones and bituminous shales of Miocene age (Scotland Series), and was first worked commercially in 1896.[10] The following are its chief characteristics: S.G. 1·10 at 77° F.; Fusion Point, 320°–340° F.; Fixed Carbon, 25–30%; Solubility in CS_2, 97–98%; Sulphur, 0·7–0·9%; Mineral Matter, 1–2%. The exceptional purity, high gloss, and intense black colour render this manjak a most effective material for the manufacture of paint and varnish.

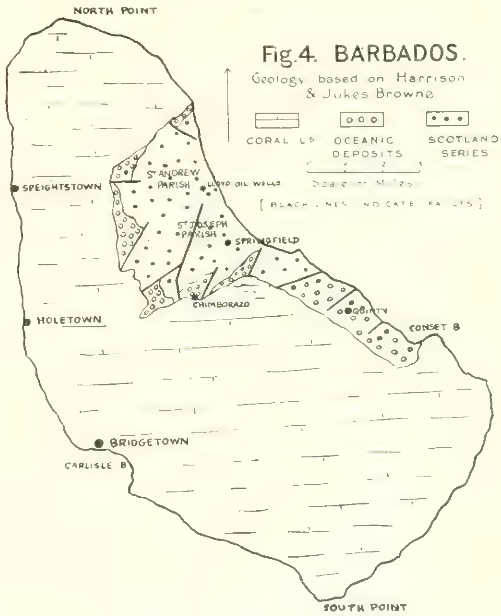


Fig.4. BARBADOS.

The geology[11] of Barbados (Fig. 4) is to a large extent hidden, much of the island being covered with coral limestone. The older rocks are exposed chiefly on the eastern side, and have been grouped as follows:

(3) *Post-Miocene—Recent*	Coral Limestones.
(2) *Miocene*	Oceanic Series.
(1) *Miocene or possibly older*	Scotland Series.

The Scotland Series is the most important for present purposes, since in many places its sandstones are petroliferous. Unfortunately these rocks are much cut up by faulting and a great deal of material has been removed by erosion. The oil indications

[9] Purves, "Esquisse géol. de l'Île Antigoa": *Bull. Nat. Hist. Belge*, iii, 1885, p. 269; Broun, "Notes on the Geol. of the Island of Antigua": *Proc. Acad. Nat. Sci., Philadelphia*, lxv, 1913, p. 584; Spencer, "Geological and Physical Development of Antigua": *Q.J.G.S.*, lvii, 1901, pp. 491–534; and F. R. C. Reed, op. cit., p. 175.

[10] Merivale, *Trans. Fed. Inst. Eng.*, xiv, 1896, p. 539.

[11] Harrison & Jukes Browne: "Geology of Barbados": *Q.J.G.S.*, xlvii, 1891, p. 197; also *Q.J.G.S.*, xlviii, 1892, p. 170.

are mainly surface pools and seepages, especially in the parishes of St. Joseph and St. Andrew, Eastern Barbados. What were originally known as the "Lloyd" wells, St. Joseph, constituted an early attempt to obtain a commercial production ; originally twenty-five in number, the wells were hand-dug to a depth of 100–140 ft., being about 5 ft. in diameter and lined with timber. In 1895 there were only five of these wells producing, each giving from 1 to 2 barrels of oil per day. At the present time fourteen

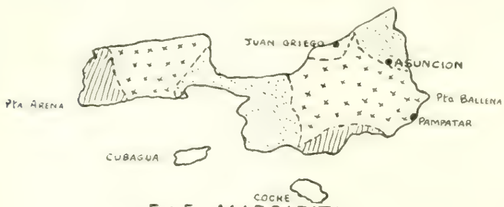


Fig. 5. MARGARITA.

wells have been drilled, but all are shallow, and only a small production has been obtained. The oil is of high grade, of asphaltic base, very mobile, and contains a good percentage of light oil. Developments are in progress, chiefly by the British Union Oil Company. The prospects appear to be very good, though expert opinion is against the likelihood of any really big wells being brought in. There is no fundamental reason why this island should not yield good results, particularly if less eroded members of the oil-bearing series can be located.

TOBAGO.—There is a great similarity in geology and tectonics between Tobago and Trinidad, the well-known metamorphic rocks of the latter island being a characteristic feature of a large part of Tobago. The sediments developed are dominantly calcareous, but no evidence of petroleum has been reported from them up to the present.

The islands of MARGARITA, TORTUGA, CAYO GRANDE, BUEN AYRE, CURACAO, and ORUBA are all, like Trinidad, remnants of the South American mainland, though structurally related to the Antillean continent. Margarita (Fig. 5) and Tortuga are situated on a parallel fold to that forming the coastal cordillera of Venezuela ; the other islands are referable to a more northern structural line, and may possibly be a continuation of the inner volcanic zone of the Lesser Antilles. Of these islands, the most important as regards oil potentialities are Margarita and Tortuga. The lower Tertiary deposits occurring in both are said to be petroliferous, and surface indications are by no means lacking, especially in Margarita.

* * * *

From what has been written it will be seen that a great deal of territory in Central America and the West Indies invites examination of its petroleum prospects, and such exploration has at least the initial advantage of possessing truly scientific possibilities.

To some it may seem that the connexion between regional tectonics and oil-land development is purely academic, because it lacks that degree of concretion necessary to its more general appreciation. This is by no means the case. There are unfortunately many whose position and responsibilities enable them to initiate petroleum investigations, and who do so with little, if any, regard for the intrinsic geological factors to be reckoned with in the particular locality of their choice. To the repeated pleadings of their consultants they are deaf, their creed being that all land is oil land unless proved by actual inspection to be otherwise. Acting on this belief, the exploration party is assembled, equipped, and sent out, probably to some isolated, uninhabited part of the world, in order to discover an oilfield which, in the region chosen, cannot by any chance exist. The appalling waste of human energy, time and money under such conditions needs little further comment here ; suffice it to say there are certain first principles controlling the ultimate locus of accumulation of a fluid such as petroleum within the earth's crust, and the recognition of these principles and the manner in which they express themselves as natural phenomena, not only concern the petroleum geologist, but everyone engaged in sincere enterprise of this kind.

No man can say just where oil will be found ; but it is possible to forecast where it will *not* be found. The region dealt with in this article is one to which a certain amount of attention has been paid in the past, but it is also one which is destined to be explored much more thoroughly in the future. If, in this connexion, what has been written helps to eliminate unpromising or impossible areas by focussing attention on the more favourable, and, *pari passu*, on those fundamental principles thus involved, which are of universal application, then it will not have been written in vain.

COPPER LEACHING AT WHIM WELL, WEST AUSTRALIA

By H. R. SLEEMAN, M.Inst.M.M.

The author gives further particulars of the Pechey leaching process devised for treating the oxidized copper ores at Whim Well, and describes his own modification of the process.

In the MAGAZINE for November there appeared a précis of Mr. Torrington Blatchford's report on the Whim Well and Mons Cupri copper mines. As the art of leaching oxidized copper ores has rapidly developed of late, and the Pechey treatment has been modified, and, further, as the publication is not quite accurate in certain particulars, I am sending you these supplementary comments.

I should start with calling attention to the remark added to the précis that " Mr. Blatchford is doubtful about the process and recommends further investigations." This, I consider, is misleading. As a matter of fact, Mr. Blatchford states " that the process is applicable for the extraction of the copper contents of the ore at Whim Well has certainly been definitely proved . . . the chemical reactions are not quite clear "; again, " though not quite satisfied with some of the chemical equations quoted, I consider that the results have proved the process a success, and I do not see any reason for doubting a successful result if the process is installed at Whim Well and worked on an extensive scale." He recommends laboratory investigations on the grounds that a more complete knowledge of the chemistry might lead to improvements in manipulation.

The above applies to the treatment of the ore with SO_2 gas whether in dumps, in vats, in a coarsely crushed state, or by fine grinding and agitation. The treatment by SO_2 gas is simple, especially if applied only to dump and to sand treatment. It is now, however, expected that a cheaper and simpler method will be utilized. This is to use pyrite in vats. The use of pyrite just before cementation for the purpose of destroying ferric sulphate, which is highly deleterious in cementation, I believe is well known and was patented in America some years ago by Mr. Joseph Irving. The idea of utilizing pyrite as a creator of solvent in solutions containing iron sulphate, is, I believe, new, though the chemistry involves nothing that is not well known.

The liquors pass through vats containing pyrite before going to the leach ore dump or vats, etc., as the case may be. On a mine having solid pyrite the simplicity and cheapness of the method is obvious. The costs of roasting and of conveying the SO_2 gas to the required spots are eliminated. The working costs in creating the solvent are negligible, as the pyrite needs replacing only at long intervals.

The initial outlay is in the vats and their pyrite contents. As a substantial tonnage of pyrite is needed relatively to the rate of copper production, this represents a fairly big outlay. It is moderate, however, compared with the outlay needed for producing and handling SO_2 gas from pyrite roasting. It is hoped that it will prove feasible to do the bulk of the leaching in the form of dumps, thus saving the handling costs attendant on vat leaching.

The idea of forming dumps direct with oxidized ore of 4% to 5% is, I believe, new. The investigations regarding it are not yet complete. The investigations regarding the use of pyrite as the creator of solvent also are not yet complete, but no doubt is felt that it will prove successful.

The proposed cycle is as follows: The cementation tails go to vats containing pyrite, thence to dump, to further pyrite vats, to leaching plant (coarse or fine, as the case may be), to final pyrite vat, and to cementation. The make-up water is added wherever circumstances indicate as best. The cementation tails contain mainly ferrous sulphate, but with small quantities of copper sulphate, sulphuric acid, and ferric sulphate. The pyrite vats ahead of the dump are manipulated so as to yield the maximum amount of solvent to the liquor. The dumps are irrigated in the usual manner, the rotation and percolation periods being arranged with a view to maintaining the maximum formation of copper sulphate, that is, the maximum extraction of copper.

In passing through the dump, part of the ferrous is oxidized to ferric sulphate, and some sulphuric acid is formed. The former attacks all the salts of copper and the latter all the oxidized salts. As part of the copper exists as chalcocite, the former is useful for

extracting its copper. Other chemical reactions take place. At present they are not fully known, and it is not proposed to speculate regarding them here. The point of practical import is that the liquor effluent from the dump carries copper sulphate, some ferric sulphate, and a little sulphuric acid, besides, of course, ferrous sulphate. In passing through the pyrite, prior to the dump, the solution becomes enriched in ferric and ferrous sulphates and acid, both its iron and sulphate elements being increased. It goes to the dump therefore strengthened for its work.

In the dump some Fe_2O_3 is deposited, probably mainly by the reaction of ferric sulphate on the oxidized copper salts. Some basic iron sulphate is also probably deposited and probably a little free sulphur. It is obvious that these depositions must not be too extensive, as they would deplete the liquor too much of its essential constituents. These considerations enter into the question of the best manner of operating the dump, the period of each flooding, etc.

The liquors from the dump are raised in this case by air-lift, and again are passed through pyrite. The extent and the manner of using the pyrite will depend upon the programme adopted. If it be desired to do as much of the leaching as possible in the form of dumps, then the pyrite at this point will be used only to convert the ferric to ferrous sulphate and acid. If it be desired to do extensive plant leaching, the aim would be to increase the solvent power of the liquor to the required degree. The liquor then passes to the leaching plant. In the former case the excess of acid is neutralized by the ore and the liquor leaves the plant weak in acid. Some ferric, however, will have been formed in the plant, and a little may have escaped the previous pyrite. As it is essential that the ferric be reduced to the practical minimum before cementation, the liquor is again passed through pyrite for the sole purpose of destroying ferric.

In the latter case the liquor may pass through two or more series of pyrite and of ore. In every case the aim must be to send liquor to cementation free from ferric and weak in acid. Up to the last stage pyrite and the ore must be handled as to produce the maximum leaching effect.

In cementation it is not proposed to aim at a very complete recovery of the copper in the liquors. The presence of copper sulphate in the tails assists the action of the following pyrite and so accelerates the leaching. Also it is when the liquors become very low in copper that the consumption of iron rises and the grade of the copper precipitate (cement) falls. It is probable also that some ferric gradually forms, by exposure to air, as the liquors pass through the cementation plant. Other causes also operate, when the liquor is low in copper, to consume iron and to foul the precipitate. As the process is cyclic—there being no solution going to waste—the presence of copper in the cementation tails does not entail appreciable loss.

The first stage proposed is to proceed with leaching the dump already on the leaching site, probably adding to this from other existing and conveniently situated dumps. With this will be used vats filled with existing fines, which are the screenings through a $\frac{5}{8}$ in. grizzly from run-of-mine ore put aside during the period of dressing ore for shipment. Only enough ore will be used to correct the liquors, as described, and only enough pyrite to convert all the ferric sulphate. This stage may be extended to include coarse crushing and the leaching of the crushed ore, as well as of existing dumps, by extending the dump and vat leaching proportionately. The ore would be reduced in the vats to probably $1\frac{1}{2}$ to 2%, and then sent to dump leaching. The ore would be crushed as fine as percolation in the subsequent leaching permits, probably $\frac{3}{4}$ to 1 in., no separation of fines being made.

The process in view as the ultimate means of dealing with the oxidized ores is as follows: To crush the ore to $\frac{1}{2}$ in. or $\frac{1}{4}$ in.; to separate the fines (everything not too coarse for treatment by thickeners); to leach the fines and make a complete extraction of its copper rapidly in a suitable plant, using probably counter-current decantation; the coarse ore to go to jigs and thence to dumps. By this means probably 50% of the copper would be recovered in treatment of a few hours. The remaining 50% going to the dump would yield half or more of its copper within a short period. The balance would be recovered at a gradually reducing rate until further leaching became unprofitable.

This treatment would require little addition or alteration to existing plant beyond that for jigging, for the fines leaching, and for additional pyrite. It would have the following advantages. The jigging recovers probably 30% of the copper, as a concentrate of some 20%, at very small cost. The fines

treatment would be cheap, there being no fine grinding. The ore going to the dump would be in ideal condition for percolation and leaching, having no slimes and no large particles. As the less leachable portions of the ore (the chalcocite) goes mostly into the jig concentrate, the leaching is accelerated, that is, occupies a shorter period before reaching the unprofitable grade. The treatment is simple and cheap.

The liquors used in leaching the fines would if necessary be strengthened at suitable points by means of additional pyrite. The question of strengthening the liquor, and if so to what degree, at this point would depend upon the proportion of the ore that was taken into the fines. It might be decided to take only as much into these as could be leached by the dump effluent without further strengthening.

A weakness in the treatment may be the proportion of chalcocite that would go into the fines. This, however, may be satisfactorily met by so handling the liquors that they will contain sufficient ferric sulphate.

The writer's experience and information covers only dumps containing either large lumps of ore or composed wholly or mainly of sulphide ore. In both of these cases the extraction of the copper extends over a considerable time. In the former case, even though the ore be oxidized, time is required for the extraction of the copper from the inside of the larger lumps. In the latter case time is required to decompose the sulphide ore and render its copper soluble. In both cases substantial periods are required between floodings, the floodings occupying only relatively brief periods. The leaching of the existing dumps will thus extend over a period of probably two years or more.

In the case of the contemplated future dumps, formed of jig tailings, these conditions will not exist and there seems no reason why their copper, or the major part of it, should not be extracted much more rapidly and indeed be more comparable to extraction in vats (as regards length of treatment) than to dumps containing large lumps of sulphide ore.

The process depends on the liquor having sufficient iron sulphate contents. At all points in the leaching it would be necessary therefore to prevent the depositing of ferric hydrate and of basic iron sulphate to an extent that would unduly rob the liquor of these. This danger, however, is unlikely to exist after the leaching has progressed for some time. Indeed, later, it may prove that the elimination of some of these salts in the fines-leaching may be desirable, as they may tend to accumulate to excess. Their elimination would presumably be effected by encouraging the presence of ferric sulphate, and of the leaching being done by it in place of acid. This would result in depositing iron hydrate. This feature may develop in any case as the liquors become surcharged with iron sulphate.

The above programme would enable vat leaching to be eliminated, with its objection of handling costs in charging and emptying and of large vat capacity.

The presence of certain chlorides in the liquor accelerates the leaching action. Sea or brackish water will be used, the supply being pumped from the coast some 10 miles distant. This will assist in the treatment.

The crudest and most unsatisfactory part of the treatment is the precipitation. The cost in iron is substantial. It is hoped that further developments in hydrometallurgy and in the circumstances of the mine will later enable this part of the treatment to be improved upon. It is hoped to accelerate dump leaching by placing a layer of sulphide, or partly sulphide, ore on top of the dumps. Conditions would be created tending to rapidly decompose this ore, and the acid and iron sulphates thereby formed would assist the leaching. Future dumps may be formed with an admixture of pyrite matter for the same purpose.

One of the great advantages in the leaching methods described is the fact that the leach liquor is never strong in solvent. Consequently it attacks such constituents of the ore as iron and alumina to a negligible degree. The solvent is being continually created and continually neutralized in dissolving the copper.

The presence of iron sulphates also has an effect of decreasing any dissolving of lime, but of this the amount is very small. The circuit of the liquors as described does not infer that the whole of the liquor effluent from the dump goes each circuit through cementation. The aim is to send the liquor to cementation with a fairly high copper content. To effect this the liquors may be passed through the dump (and perhaps the vats or fines plant) more than once before going to cementation.

It is probable that, after a time, the accumulation of iron sulphate in the dumps

may reduce the need for the pyrite, and that consequently the tonnage could be increased without increase of pyrite. If sulphide ore be spread on the surface of the dumps or be mixed with new dumps, that effect certainly should result.

Additionally to the main treatment, above outlined, large quantities of lower grade ore, say, under 3%, will probably be treated by direct dump leaching, the ore being merely crushed to a suitable size (say, 2 to 3 in.), and sent direct to the dumps. The liquors from this would probably be corrected for excess ferric sulphate in the fines leaching, as well as by pyrite, before going to cementation.

The output of copper will probably be further supplemented by high-grade ore. As the average ore is excavated, patches of rich ore are encountered. It will probably pay in such parts to put the rich ore direct into bags for export. Such ore would be 20% and over.

The foregoing applies largely also to the Mons Cupri mine. In that case jigging is not likely to be used, being less suitable. As the ore will also form less slime in crushing, and as the grade is lower, and as the conditions there are pre-eminently favourable for dump leaching, while power and plant operating costs will be somewhat higher than at Whim Well, it is probable that treatment will be restricted to dump and vat leaching, and that the former will be the main factor, the latter being restricted to the extent necessary for the correction of the liquors.

[See letter p. 26.—EDITOR.]

BOOK REVIEWS

Investigations of Zirconium, with especial reference to the Metal and Oxide. By J. W. MARDEN and M. N. RICH. Bulletin No. 186 of the United States Bureau of Mines.

Much has been written about zirconium and its compounds in recent years, for investigations have indicated that they possess useful properties. The metal is very resistive to acids, and it has been proposed as an alloy for special steels, while its oxide has been recommended as a refractory suitable for very high temperatures.

Zirconium has been termed a mystery metal, for merits have been ascribed to it by some, while it has been condemned by others; and the unknown always exercises a certain fascination in the human mind. Some of us can remember that exaggerated claims were formerly made for aluminium which were not sustained, although, following the depression after over-enthusiasm, aluminium has made continued progress in industrial use. Zirconium and its compounds are similarly passing through a period when the original hopes regarding them are not being realized, although doubtless, when their properties become better known, they will be found to have a widening field of usefulness.

In the course of the special work on rare metals of military importance during the war, the authors of this bulletin were detailed to the Golden Mining Experiment Station of the American Bureau of Mines to prepare metallic zirconium and its salts, and investigate their properties. This work was carried out with the thoroughness one associates with the American Bureau of Mines, and the results of the investigation are presented in this monograph, which constitutes a most valuable and complete treatise on the subject.

Part 1 is a historical review of the chief minerals, the salts of zirconium, and zirconium metal, while Part 2 deals with the experimental and research work carried out. The authors initiated their task by perusing all the available literature dealing with the metal and its compounds, which they have listed in the bulletin as a bibliography. Pure salts not being available, they prepared their own, giving careful attention to the methods of analysis. Mention is made of the difficulty the authors experienced in dealing with the literature on the subject, owing to the confusion of terms by various observers who perhaps did not understand the chemistry of zirconium.

The principal zirconium minerals are: zircon, the silicate, and baddeleyite (brazilite) the oxide. The former occurs in placer deposits derived from the disintegration of granite and pegmatitic rocks; it is found in the United States, Brazil, and other places generally associated with monazite sands containing ilmenite and magnetite, from which it is separated by magnetic concentration, the tailing being dealt with on Wilfley tables. Baddeleyite occurs in large deposits in the States of São Paulo and Minas Geraes, Brazil, but it has been

identified elsewhere. It is the principal constituent of zirkite, the predominant Brazilian mineral reported by Derby and Lee to contain also zircon and an unnamed silicate. The outcrop has been traced for a length of 15 miles, so if surface indications are of any significance the ore-bodies should be large. The deposits are distant from railway transport, and owing to the extreme hardness of the mineral, fire-setting employed by the Naxos emery miners is in use for breaking down the ore.

Pure zirconium salts are not easy to obtain direct from the ore, owing to the difficulty of making a complete separation from other elements, especially titanium, the two elements being closely allied in their chemical behaviour. The various methods for the recovery of zirconium from the ore and the purification of the chief zirconium compounds are described. Zirconium oxide is the principal compound at present marketed, owing to its stability, ease of handling, and because it has much commercial use at present. Zirconia is usually amorphous, and consists of a white powder when finely pulverized, which is inert towards chemical agents in proportion to the temperature at which it has previously been ignited. Unless previously fused it cannot be used successfully for refractory ware, and no suitable binders of other material are known that do not appreciably lower the melting point, which in the pure material is said to equal 2,950° C., compared with 2,800° C. for magnesia. The fused material, when ground to 200 mesh, becomes collodial in the presence of water, and thus enables it to be used as a binder. Its low coefficient of expansion permits a red-hot dish prepared from the fused material to be placed in cold water without cracking, and this property, as well as its resistance to fused alkalies, cyanides, and acids, has made it suitable for chemical ware.

A number of other uses have been suggested for zirconia, among which may be mentioned that of an abrasive, and in the enamel industry as an opaquing medium. Zirconium salts have also been tried as mordants with satisfactory results in certain cases.

The various published analytical methods are referred to, and it is remarked that in some at least there is much to be desired as regards simplicity and accuracy. The literature also regarding zirconium metal shows great disagreement regarding its properties, partly because the different varieties of the metal have been confused, and also owing to the difficulty of preparing pure products. In dealing with zirconium alloys, mention is made of experiments which have proved that a small percentage of zirconium in steel increases the strength and hardness to a remarkable degree, and an investigation of zirconium steel and its use for war purposes has been made by the Bureau of Mines, which will shortly publish a bulletin on alloy steels. This knowledge was apparently possessed by Germany, for during the war they produced a zirconium steel which it was claimed possessed properties superior to that of other alloy steels for thin armour plate and other purposes.

Part 2, dealing with the experimental work carried out by the authors, is of great value, for they have tried practically all the known methods of treatment of the ores, and the preparation of pure salts and the metal. The raw materials used were high-grade zircon, zircon sands from Florida, and zirkite from Brazil.

Ore-dressing experiments were carried out to determine whether the native product could compete with Brazilian material. These gave promising results, as tabling removed most of the titanium oxide and silica. Good extractions of zirconium were obtained from zirkite or zircon by fusing with caustic soda, soda ash, or mixtures of the two; and the treatment of zirkite with sulphuric acid yielded good results, but only when ignited at 650° C., as at lower temperatures the solubility of the neutral sulphate in water is reduced, or because insoluble basic sulphates of zirconium are formed.

The most useful method of preparing pure zirconium oxide was to recrystallize the double fluorides of potassium and zirconium, but it was found too expensive for commercial use. The basic sulphate method of crystallization was tried, and oxide of zirconium of 99·84% purity was prepared by this method for 20 cents per pound, or half the cost of any other known method.

Published methods of analysis were unsatisfactory and gave results on the same sample varying between 47% and 87% zirconium oxide. The phosphate method of precipitation was satisfactory under certain conditions, but the cupferron process yielded very accurate results for iron and zirconium, it being the only precipitant which accurately separates zirconium from aluminium. Details of analytical methods

are given which have been carefully worked out by the authors, and should be of great value for those engaged on zirconium estimations.

All the methods listed in the literature, except one, were tried for the production of amorphous zirconium. By the reduction of potassium zirconium fluoride by sodium, amorphous zirconium of 98% purity was obtained. Attempts to fuse this product resulted in failure, owing to the formation of oxides by occluded gases. It was also produced by reduction of the K_2ZrF_6 in an Arsem vacuum furnace by aluminium. A method of preparing a commercial grade of amorphous zirconium from crude ore was also devised, and gave excellent results.

The physical and chemical properties of the purest samples of the amorphous metal produced are given.

The alumino-thermic method was tested for the production of the solid white metal termed "coherent zirconium", but the difference in the heat of formation of the zirconium oxide and alumina was not sufficient to melt the product. Potassium chlorate was then added, and on the ignition being started by a magnesium ribbon, metallic zirconium formed in small beads which contained 99·5% zirconium and small quantities of titanium, iron, silicon, and alumina. Similar results were also obtained with the vacuum arc method, and the reduction of potassium zirconium fluoride with excess of aluminium in the Arsem vacuum furnace. Attempts to reduce zirconium oxide with metals other than aluminium were failures.

The physical and chemical properties of the coherent metal produced are given. It readily scratches glass and is quite brittle. It is found that when samples of zirconium are fused in pure dry hydrogen at a temperature of 1,700° C. and rapidly cooled, they exhibit a feature similar to the so-called "spitting" of silver. It is insoluble in all acids except aqua regia and hydrofluoric acid, and for that reason has been suggested as a substitute for platinum in certain cases, and also in the manufacture of rust-resisting apparatus.

An examination of the so-called crystallized zirconium showed it to be an aluminium-zirconium alloy containing about 72% Zr and 27% Al. It is the easiest formed alloy of zirconium, and it is suggested that it might be commercially used. Zirconium will alloy with silver and nickel, but not with lead and tin, and it will not amalgamate. Ferro-zirconium, reputed to be malleable and ductile, was not found so when prepared by the authors; it can be made by the alumino-thermic reduction or in the arc furnace.

In the course of the investigations trouble was experienced in finding crucibles for use in the Arsem furnace. Aluminium oxide crucibles disintegrated or cracked, and as zirconium oxide melts at the higher temperature it was hoped that crucibles could be prepared which would give better results. Experiments were carried out and it was found that by igniting pure zirconium oxide at a high temperature before grinding, and the use of plaster of paris moulds, satisfactory results were obtained. There was still a shrinkage of about 30%, but the crucibles were nearly as hard as unglazed porcelain and withstood a higher temperature than the alumina crucibles.

This monograph well repays perusal, for it bears the stamp of impartiality, and has, as it were, separated the wheat from the chaff in the literature dealing with this little-known metal and its compounds. Metallurgists are under a debt of gratitude to the American Bureau of Mines for making the results of the investigation public.

HERBERT K. SCOTT.

The Law of Mines, Quarries, and Minerals. By R. F. MACSWINNEY, Barrister at Law. Fifth edition. Price 45s. net. London: Sweet & Maxwell, Ltd.

That a fifth edition of this well-known work has been called for is in itself a testimony of its value. From even a casual perusal it will be obvious that a vast amount of labour as well as ability has been spent in dealing with the subject in clear and concise language. The book will be found of great value, not only to the legal profession, but also to a large number of persons engaged in mining enterprises who are not lawyers. Mining men may be disappointed that some chapters in the last edition of the work, which especially appealed to them, have been omitted from this edition; but owing to the abnormal conditions now existing, including cost of printing, etc., that omission seems to have been inevitable. With that exception the present work may be considered as covering the whole ground. It deals in the early part with the meaning of mines, quarries, minerals, and the like words and expressions, and after a useful chapter on property and possession there are four

chapters on working and user founded on property or possession as well as on custom, prescription, and statute, and as between co-owners and partners. There are then chapters on powers of dealing with properties with respect to sales, purchases, leases, etc., and separate chapters relating to leases and licences, and four chapters relating to neighbours and dealing with important questions of support, incidental rights, roadways, water, and air. The book concludes with a chapter on wrongful possession and wrongful abstraction, and a condensed, but useful, survey of taxes, dues, rates, and tithes.

It would not be expected in such a work for all points to be dealt with, as this would have meant a much larger treatise, but by the arrangements adopted of numbered paragraphs from beginning to end of the book, together with references on every page to the authorities either in decided cases or Acts of Parliament, the reader consulting the work on a given point is enabled to pursue further inquiries in the Acts of Parliament themselves or in the reported decisions of the cases. There is a full list of cases and an excellent index, and the general format of the book is of the best.

It might be useful when a further edition is called for, as we anticipate will be the case, if the editor would deal with one or two questions on which the mining world is rather in doubt, particularly such questions as what is meant by a failing mine under the Income Tax Act, and what is the principle of rating mines if and when such mines cease operations but are not abandoned. We also suggest to the publishers that it would be worth while to consider issuing to purchasers of the volume a short annual supplement by way of notes on any important change in the laws. For instance, the editor, in considering the very important question as to the liability of those working minerals if the surface is let down by such workings, deals with the well-known case of Consett Waterworks Co. v. Ritson, where it was held that the Lanchester Inclosure Act, 1773, gave the mine-owners the right to work the mines so as to let down the surface without liability to the allottees; but since this work was published the Court of Appeal has held that this Consett case is still binding, the House of Lords having declined to overrule the same.

C. V. THOMAS.

☞ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, London, E.C.2.

LETTERS TO THE EDITOR

Salaries of Young Engineers

The Editor:

SIR—A case recently occurred of a graduate of the Royal School of Mines being engaged by a large mining corporation to proceed to a tropical climate in the East at a salary of £230 per annum, room and medical attendance only furnished free.

I find it difficult to write with due restraint confronted by what would appear to be a case of advantage being taken of the existing lack of employment in the mining industry to underpay a young engineer; but I will endeavour to set forth dispassionately a few points which may have escaped the attention of the employing corporation in the case cited. The Associateship course at the Royal School of Mines costs, including fees, living expenses, etc., £800. The wartime student graduates at the age of, say, 25. Is he not entitled to expect to pay off all the expenses of his education by the time he attains the age of 30? In other words, to receive a salary that will enable him to save an average of £160 per annum over the first five years of his career.

The young engineer is called upon to seek his living in localities where he risks his health and where the ordinary amusements and amenities of life in England are denied him. His day's work, be it in the hot, fetid atmosphere of the mine or in the cyanide plant, is far more arduous and exacting than that of the city clerk. Yet I venture to assert that there are few legal, banking, or commercial houses in London paying less than £230 a year to men of a smaller mental calibre and a far lower standard of education than the average graduate of the Royal School of Mines.

If the young engineer is intelligently used there can be no doubt that if his initial salary is fixed on a basis of £160 per annum over and above the entire cost of subsistence in accordance with the usual standards of his class, his employers will still be left with a large margin of profit on the transaction.

I appeal to you, Sir, as Editor of a magazine which has always championed the square deal in mining, to give this letter the publicity of your columns.

E. G. LAWFORD.

Pachuca, Mexico, *May* 25.

[Reference is made to this letter in our Editorial columns.—EDITOR.]

The Pechey Copper Leaching Process

The Editor :

SIR,—I have read in your issue of November, 1921, a precis of the leaching process which was in use at Whim Well in 1920 when Mr. Blatchford visited the mine, and which was the subject of a report by him to the West Australian Government. The process as practised at Mount Hope was described by the writer in *Chemical Engineering and Mining Review* (Melbourne), in the number for March, 1922, the object being to put before the reader such information as seemed to be pertinent to a clear understanding of what really constituted the modus operandi as apart from any other treatment which may have been introduced or proposed for Whim Well. [We give extracts from the paper mentioned in the Mining Digest this month.—EDITOR.] In this connexion it should first be stated in order to avoid confusion that the use of the pyrite filter was proposed by Mr. H. R. Sleeman, and is not part of the Pechey process.

Referring to your precis, you say "But Mr. Blatchford is doubtful about the process." As a result of this gentleman's investigation he advises in his report that the Government provide the necessary supply, and says: "With regard to the leaching process, I have given this particular attention, and though not satisfied with some of the chemical reactions quoted, consider that the results have proved the process a success, and I do not see any reason for doubting a successful result if the process is installed at Whim Well and worked on an extensive scale." It is not a new thing for metallurgical chemists to differ in their views regarding the actual reactions which take place in a treatment process, especially when there may be difficulties in the way of actual proof in the laboratory. If the Government staff of chemists undertake to elucidate some of the problems they will be conferring a lasting benefit on those whose time is largely taken up with the practical side of things, and the work which they often have to do with a very scanty laboratory equipment.

If I might be allowed to suggest, I would recommend that the investigation be not confined to the laboratory only, but be amply extended in the direction of 1 cwt. tests of ore when the measurement of reagents and products could be made in large quantities.

With reference to what is said about basic sulphates in the solutions, I agree with the opinion given. Basic sulphates are, according to my experience, present in the reacting heap, which, when washed and dissolved out by the down-coming solution, decompose in some manner forming normal ferric sulphate and sulphuric acid. I do not know of any case of basic sulphates having existed in the dump effluent, and I should hardly think they could exist in the presence of free acid.

Mr. Blatchford mentions an improved process which I explained to him personally in rather short form as the time at our disposal was limited. The process refers to a long series of experiments at Mount Hope, which were later duplicated at Whim Well. Fine ore was agitated in a series of Brown agitators or pachucas, by means of air carrying sulphur dioxide, when in the case of 3% copper ore the oxidized copper was dissolved and found to be mainly present in the solution as sulphate.

Iron, alumina, and the earths also dissolve more or less, but after several years of experimenting I believe that the formulas given to Mr. Blatchford, if not explaining the complete series of reactions, at least illustrate the final result as far as the copper is concerned. On several occasions when my air supply was too strongly charged with sulphur dioxide, I noticed the presence of sulphites and the precipitation of cupric sulphite (a white salt) when washing the residues. It is well known that this salt can be produced by dissolving oxide or carbonate of copper in sulphurous acid as follows :—

$$3CuO + 3SO_2 = 3CuSO_3.$$

It is also known that similar reactions occur with oxide and carbonate of iron, which are of a similar nature :—

$$Fe_2O_3 + 3H_2SO_3 = Fe_2(SO_4)_3 + 3H_2O.$$

$$FeCO_3 + H_2SO_3 + 2H_2O = FeSO_3 + 3H_2O + CO_2.$$

The above reactions are rather slow, but if chlorides of the alkalies or earths are present or certain metallic sulphates, they are quite largely accentuated.

I believe that the steps by which the copper finally reaches the form of cupric sulphate are complex.

When it is considered also that the water may be partly brine and charged as at Mount Hope with both sodium and magnesium chlorides the chemical equations involved must be still more difficult to trace.

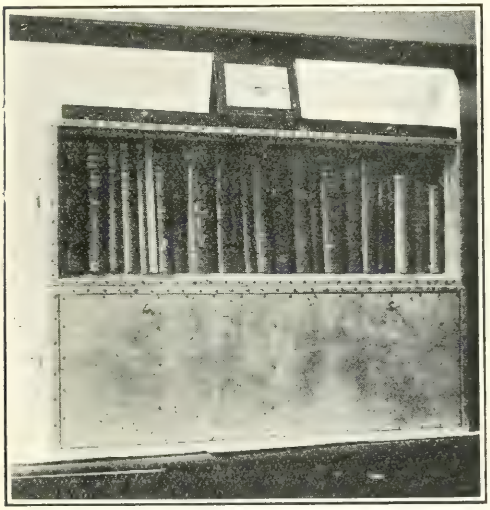
J. D. AUDLEY SMITH.

Sydney, *April* 11.

A Travelling Book-Case Unit

The Editor:

SIR—It will probably be granted that for a professional man of the engineering variety a technical library, of large or small dimensions, is a necessity, and, as a corollary, it follows that adequate access must be had to such a library; and, further, that those engineers whose professional work obliges them to proceed to, and perhaps reside in, positions more or less remote from centres of civilization will be forced to own and take with them the books of reference, etc., which will be necessary or of assistance for the work in hand.



Generally in such cases the required books are included in the same boxes or trunks as wearing apparel, boots, and other impedimenta and, no matter how packed, orthodox or general methods of packing are seldom satisfactory and are mostly superlatively inconvenient. The question of obtaining a convenient container or travelling book-case, in which books can be packed and satisfactorily carried under practically all conditions and methods of transport, would, at first sight, appear a comparatively easy matter, but if a travelling book-case is to be specially acquired it is as well to obtain one which will, as far as possible, suit all conditions that it may encounter, and which also will permit of its contents being available and apparent with a minimum of time, trouble, and inconvenience.

It is believed that the two units (top one open, bottom one closed) here illustrated fulfil most of the requirements encountered, and they certainly have proved themselves to be convenient. Each unit is made of seasoned teak (on account of white ants), and is covered with sheet zinc to resist average baggage-handling methods; also the handles are of the drop variety, and are sunk so that except when in use they are flush with the surface of the box. The lid or front is not hinged, but consists of a loose board having on its lower long edge two metal dowel or steady pins, which, when the front is in place, fit into two corresponding sockets in the lower front edge of the box itself. The box can then be closed by turning the keys of the two locks, situated at the top long edge of the lid, these locks being, when the box is in its proper position, vertically above the dowel pins. There is a rubber seating between the lid, or front, and the body of the box, which assures that the box, when closed, is airtight and waterproof.

As will be seen, the simple removal of the front allows of immediate access to the contents, which are in the same position as if on a bookshelf.

The most convenient size has been found to be (interior dimensions) 24 in. long, by $9\frac{3}{4}$ in. high, by $6\frac{3}{4}$ in. deep, which allows for the standard size known as large octavo.

GEORGE P. CHAPLIN,
B.Sc., M.Inst.M.M., A.M.Inst.P.T.

London, *May* 26.

[Mr. Chaplin draws attention to a question that always troubles the travelling engineer. Readers interested in this matter can obtain further information about the book-case from the Technical Bookshop of THE MINING MAGAZINE.]

Two Frecheville research fellowships are being offered by the Imperial College of Science and Technology, South Kensington, under the terms set forth in an advertisement in this issue. Each fellowship is worth £300 and covers one year, with a possible renewal for a second year. The object of the founder of the fellowship is to encourage investigations into any subject connected with mining, geology, metallurgy, or the technology of oil. Preferably the fellowships will be awarded to men who have some practical experience. Applications should be made to the Secretary of the College before September 1.

NEWS LETTERS

MELBOURNE

May 25.

ELECTROLYTIC ZINC.—In Australia the post-war outlook, as is to be expected, is distinct from that in the older countries of Europe, for while on your side of the world you are faced with the problem of recovering lost trade, in the Commonwealth attention is being directed chiefly to the development of new industries.

Until 1914 Australia exported her crude metals and concentrated ores to Europe for treatment, and thus lost all the value added to the metals by the refining and manufacturing processes. In Great Britain there were few plants of any size for treating metalliferous ores, and Germany was quick to seize her opportunity. During the two decades preceding the war she had steadily strengthened her hold upon the world's metal market, until she virtually held a monopoly. Consequently, on the outbreak of war, Great Britain found herself short of some of the most essential metals for making munitions. Zinc ore there was in plenty within the British Empire, and the seas were open to British ships; but because England lacked the necessary plant to produce the refined metal in sufficient quantity she was forced to buy in the only available market—America. The need was so great and so urgent that the price of the metal rose to exorbitant figures, and deposits of zinc over the length and breadth of North America were rapidly exploited.

For the manufacture of munitions zinc of the highest possible purity is needed, and by the electrolytic process metal with a 99·95 percentage of purity can be obtained. Under the older method of distillation such a standard was impossible.

The largest zinc deposits in the British Empire are situated at Broken Hill, New South Wales, and, as your readers are already aware, some of the principal companies operating in that field turned their attention to the problem of recovering zinc of high purity from the Broken Hill ores by the electrolytic process, and with this end in view formed the Electrolytic Zinc Company, Ltd. An excellent site for the new company's plant was obtained on the Derwent River, at Risdon, near Hobart, Tasmania. The chief factor in determining this choice of site was that Tasmania was at that time the only state in the Commonwealth where electrical power in the large quantities required for the process could be obtained.

As soon as the power became available, the company erected a small experimental plant at Risdon for the purpose of proving whether the electrolytic process could be profitably used on Broken Hill ores. This small plant was designed to produce 10 tons of zinc per day; but in actual working it turned out approximately 15 tons per day. Having thus proved the soundness of the enterprise, the company proceeded, without delay, to erect buildings and plant for the production of at least 100 tons of metallic zinc per day.

So extensive was the undertaking that it was desirable to erect the plant in two main divisions, each with a designed minimum capacity of 50 tons of metallic zinc per day. The first division was put into operation in November of last year, and the output of zinc has steadily mounted until it has substantially exceeded the estimated capacity.

The plant at Risdon is the only one of its kind in the Southern Hemisphere, and for size is rivalled by only one other, that of the Anaconda Company, at Great Falls, U.S.A.

The following particulars will give some idea of the magnitude of this undertaking. In giving these particulars the object is to interest the business man and general reader rather than the technologist, who, however, may find one or two points that will fill in his present knowledge.

The raw material used is zinc concentrate in which zinc exists in combination with sulphur. In addition to the zinc, other metals, particularly lead and sulphur, are also present. The first step in the extraction of zinc from sulphide ores is to break up the combination between the zinc and sulphur. This is carried out by roasting in such a manner that the sulphur is available for conversion into sulphuric acid, which is used extensively in the Commonwealth for the production of superphosphate. It is interesting to note that when the company's plant is in full operation approximately 125,000 tons of zinc concentrate will be required annually, from which sulphur gas equivalent to the product from 30,000 tons of sulphur will be available for the manufacture of acid.

During the roasting process the zinc sulphide is converted mainly to zinc oxide. This material is dissolved from the ore by

leaching with sulphuric acid, and a solution of zinc sulphate is formed. It is necessary thoroughly to purify this solution before it passes to the electrolytic cells, and it is interesting to point out that this purification process is one of the most important steps in the production of zinc by the electrolytic method. In a later communication it may be possible to give technical details of the process. The purified solution is run through electrolytic cells which are lead-lined rectangular wooden boxes. During its passage through the cells the zinc sulphate is broken up, with the result that metallic zinc is plated out on the cathode, the sulphuric acid being regenerated and used again.

The electrical energy is generated by the Hydro-Electric Department of Tasmania at its power-house at Waddamana, below the Great Lake, on the high central plateau of the island. The heavy rainfall and the snow which, at times, is also very heavy, on the plateau provide the continuous water-pressure required for the scheme. Of the power generated, the company will take 30,000 horse-power, equal to 196,000,000 kilowatt-hours per annum. This power is greater than that generated in the Glasgow power stations for municipal and industrial purposes in that city.

From the Waddamana power station the current, at 88,000 volts pressure, is carried by copper conductors a distance of 65 miles to the substation at Risdon, where its pressure is reduced to 11,000 volts for distribution, and the company's works are supplied at this pressure through underground cables for a distance of 500 yards. Besides being at too high a voltage for the purpose required of it, the power is also supplied in an alternating current which is unsuitable in the process of electrolysis. It is therefore necessary to transform the current from a high to a low voltage and to convert it from an alternating current to a direct current to make it suitable for use as an electro-chemical agent. For this purpose the company's power station has been fitted with seven rotary converters each of 3,000 kilowatt capacity, equivalent to about 4,000 h.p. Each rotary converter equipment consists of the necessary 11,000 volts switchgear, static transformers for stepping down the voltage, and the rotary converter which transforms the alternating current to the required direct current. The direct current, now at a suitably low pressure, is led from the company's converters by copper busbars to the groups of electrolytic cells through each of which a current of from 10,000 to 12,000 amperes is passed. Nine-tenths of the electrical energy supplied to the company is employed in this process.

In addition to the direct current required for the electrolytic cells, the company's power-house supplies alternating current at 415 volts for general power purposes and at 240 volts for lighting, and for this an additional set of static transformers is provided. The various appliances operated by means of this power include two large electric locomotive grab-cranes on the company's wharf on the River Derwent for unloading the steamers conveying ore from the mainland; belt conveyers for carrying the ore from the wharf to the storage bins, and thence to the roasting furnaces and the leaching division of the plant; an electric shovel with a capacity of 60 tons hourly for lifting ore in the storage bins and haulage motors; elevators, pumps, and various laboratory appliances. The power-house is also fitted with two air-compressors of large capacity for supplying compressed air used throughout the works.

The cell room, which is supplied with direct current from the rotary converters, is divided into three sections, and the electrical connexions are so arranged that there are always two converters connected with each section of the cell room. A spare machine is provided with special switching arrangements for connexion to any of the three cell-room circuits should any of the other converters be shut down for overhaul.

In order to prevent accidents to operators by contact with any of the 11,000 volt connexions, the whole of the 11,000 volt switchgear is mounted in concrete cubicles, provided with locked iron doors. Each circuit is contained in its own cubicle, and the doors of these cubicles are so interlocked with the switches that it is impossible to open the doors while the circuits are alive. The contacts of these switches are immersed in oil, and are provided with an electro-magnetic control so that they can be opened or closed at a distance by means of a small operating switch, which is mounted on the control board. This system, which is installed in all up-to-date power-houses, is known as "remote control." Direct current is necessary for the circuits controlling and operating the 11,000 volt switches, and to ensure that this is always available, even

in a case of complete shut-down by the Hydro-Electric Department, a storage battery is installed which is charged from time to time by a small motor-generator provided for the purpose. In the event of a complete stoppage of power during the night emergency lights throughout the plant could be supplied by this storage battery.

So steady is the load that a load factor of over 95% is usually obtained. From the point of view of the generating plant this load is ideal, in that the power factor can be set approximately at unity. It is this continuity and steadiness of the load which is one of the characteristic features of the plant demand. The peak loads associated with ordinary power-house practice are absent. The whole of the electrical equipment of the plant is of modern design, and is laid out with a view to obtaining the greatest possible economy and efficiency.

Compared with the older methods of producing zinc by distillation, the electrolytic process as employed at Risdon has the great advantages of a cheap supply of electrical energy, infinitely better conditions for the workers employed, greater ease of control, and a product of higher purity.

BRISBANE

May 18.

Queensland in 1921.—The official record of the Queensland mining industry for the year 1921, just published, is not a cheering document. Owing to the extremely unfavourable position of the world's metal markets, which paralysed mining in nearly all its branches, the total value of the mineral output of the State was only £1,456,436, as against £3,461,975 for the preceding year, or a decrease of over £2,000,000. The large copper mining companies of the Cloncurry district did no smelting during the year, although proceeding with some development work in certain of their mines ; and the Mount Morgan Company did not resume operations after closing down at Easter, because the men at the mine and works refused to accept a reduction in wages and it was impossible to carry on without a loss and pay the rates then ruling. Other branches of mining were detrimentally affected to an equal extent, except coal, which had a yield not far short of that of 1920. Of the total of £840,000 distributed in Australia by the Gold Producers' Association, Queensland received £111,500, and this sum materially helped to keep going the declining fields of Gympie and Charters Towers as well as some of the other gold-producing centres ; otherwise the decline in the gold yield would have been much greater than it was.

Almost the only satisfactory feature disclosed in the departmental report is that such development work as was carried on in the copper areas of the vast Cloncurry district and on the Herberton and Kangaroo Hills tinfields, had in many places encouraging results likely to lead to improved production when the prices of metals increase, and wages as well as other costs of production are reduced sufficiently. At Kangaroo Hills, inland from the port of Ingham, north of Townsville, particularly good results have been obtained from the Sardine, the only tin mine that has been worked at a profit in Australia for over a year, and the mineral country explored in its vicinity is holding out great promise for the future.

In addition, two factors are mentioned in the official report as probable means of improvement in the mineral yield of the State when prices improve, these being the hopeful possibilities of the Mount Coolon goldfield and the reopening of the mines of the old Palmer goldfield. Regarding the value of these, however, there is very little material on which to base much hope. Except at one mine not much work of a profitable nature has been done at Mount Coolon, which is comparatively a new district, and the best the Government geologists who have examined it can say for it is that the indications are such as to warrant further prospecting. The Palmer district, which at one time, many years ago, gave excellent returns, was abandoned when the wet country was reached, and the influx of water into the mines became too great to be successfully overcome with the means and capital then available. Of late the principal mine of the district has been unwatered by the Government, and leased under favourable conditions to a private party, who intends to give the property a thorough trial. While, however, a report by the late Dr. Logan Jack, made when he was the Queensland Government geologist some thirty years ago, has been frequently quoted of late as to the possibilities of the Palmer field at that time, nothing has been made definitely known as to what was actually disclosed when the water had been got out of the mine and prospects had been taken from the bottom, except a statement made by the Minister for Mines that the Government experts do not agree.

The Sardine tin mine, referred to above, during last year produced, from development work only, tin concentrate to the extent of over 200 tons from 826 tons of ore, and has at present ore reserved sufficient to yield 1,000 tons of black tin. The company owning the mine has paid back to its shareholders in dividends more than half the capital put into the concern, distributing £18,000 in eighteen months, and is still being profitably worked notwithstanding the continually falling price of tin. A Government geologist, after a recent examination, pronounced the property to be one of the best high-grade tin mines in the Commonwealth, and since then further developments have gone to prove that its value continues to improve with depth.

Among the State mining enterprises carried on during the past year were the completion of the equipment of the Bowen River coal mine, ready for a large output as soon as the railway connecting the field with the port of Bowen is finished, which it is expected to be about September next ; the development of the coal measures at Baralaba, on the Dawson River, and at the Styx River, between Rockhampton and Mackay ; the operation of the Chillagoe smelters ; the production of arsenic at Jibbenbar ; and some further work at the Roma oil bore. The Government coal mine at the Bowen River was opened primarily for the purpose of supplying coal for the proposed State iron and steel works at Bowen ; but, for the want of funds, these works have not been started, nor are they likely to be, and if the colliery is to prove a commercial success a market for the coal will now have to be found elsewhere. In order to keep men in employment and to assist the miners in the North, the Chillagoe smelters were kept in commission by the Government last year from the beginning of June till the end of November, and the copper and other metals produced were stored to await a better market, which has not yet materialized. The accumulated metals are said to reach a value of over £100,000. The mine at Jibbenbar, which has been supplying arsenic at £10 per ton for prickly pear destruction, closed down sometime before Christmas because the supply had overtaken the demand, and remained idle till a week or two ago.

Iron and Steel.—Over three years ago the Government of Queensland appointed Mr. J. W. Brophy, from the iron and steel works at Newcastle, New South Wales, as general manager of the proposed iron and steel works at Bowen, Queensland, the term of his engagement being five years and his salary £1,500 per annum. Incidentally, it may be mentioned that some time afterwards, presumably on his recommendation, the Government bought the iron ore deposit at Yampi Sound, on the north-west coast of West Australia, at a cost of £30,000. The fact that the large works at Newcastle have practically ceased operations because they cannot compete with imported iron and steel under present conditions has put the consummation of the Government's hopes of establishing similar works further off than ever. Mr. Brophy's occupation having thus gone—or, rather, never having materialized—another position has now been made for him, and he has been appointed Superintendent of State Collieries. The supervision of these collieries was previously a part of the duties of the State Mining Engineer, who is also Chief Inspector of Mines, at a salary less than half that being paid to Mr. Brophy. It is understood that the former officer had too much to do, and that he ought to have had a deputy ; but to appoint another officer at a salary so much higher to do part of what was his work has created an anomalous position which is not considered compatible with the harmonious and efficient working of the Department of Mines.

Gold Mining.—The Queensland Government is continuing to extend its State enterprise in other directions, and has just completed a new battery at Kidston, a goldfield in the Etheridge district, in the north. The mines of the Kidston district are all low-grade propositions, and in order that they may be made to pay it is necessary to crush the ore in quantity and economically. In this case it is admitted that private mills were not meeting crushing requirements, and that if the Government had not come forward with their battery there would have been a danger of the field deteriorating if not ceasing to exist. Whether this latest of Queensland's State enterprises will prove remunerative remains to be seen. The State battery at Bamford, which is now idle, was built solely to assist the miners of the district, and it has been run at a loss when run at all. However, at Kidston, there has been stacked a good deal of ore awaiting the completion of the mill, and the holders of the mines expect that supplies will be kept up without difficulty.

On the Woolgar portion of the Etheridge field the owners of a mine called the Perseverance, having already obtained help from the Government in the purchase of a Wilfley table, are asking for State financial assistance to open up their mine. An average sample taken from this property gave the encouraging result of 2 oz. of gold per ton, and a recent crushing of 10 tons yielded 14 oz. of gold bullion, worth £41. The owners of the mine intend to thoroughly test their ground.

Another of the old, and at one time famous, mines of the Gympie goldfield has passed into oblivion, the North Smithfield Company having sold its plant and applied for a winding-up order. This company has worked continuously for about forty years. During that time a lot of gold has been obtained from the mine, and for many years regular dividends were paid, but the poor results of recent times have brought about the inevitable end. Mining on this field has now almost died out, but the valley of the Mary River, on which the Gympie township is situated, is becoming noted for successful dairy farming, which is a more enduring occupation than the search for gold.

On the Charters Towers goldfield, which has not the same natural advantages as Gympie apart from mining, one of its oldest mines—that of Clark's Gold Mines, Ltd.—is still going strong, and a few smaller mines of more recent date are giving promise of some reward for the enterprise of their owners. On one of these holdings, called the Bonnie St. Andrew, a large reef has been opened up, and the ore continues to improve in value, giving assay results of about 1½ oz. per ton, with some silver, which is well within the profit-making margin. On the same field, the Mount Clear View mine, which had been lately sampled by the Australian representative of a British firm holding an option of purchase over the property, has exposed 6 ft. of ore in a winze down 66 ft., but its quality has not yet been ascertained.

THE MUNGANA MINES.—The Girofla, one of the Mungana mines lately acquired by the Government as feeders for the Chillagoe State smelters, is now producing 500 tons of ore per week. Stoping is proceeding in Nos. 2 and 3 levels, and about 20 ft. of good silver ore has been proved, while a further extension of the shoot that appeared in No. 4 level is being sought. These Mungana mines, which also include the Lady Jane, were for a time worked by the Government on an option for purchase, the Mines Department paying a royalty, amounting to 4% of the value of the ore won, to the company which then owned them, and which had taken up the leases after they had been abandoned by the Chillagoe Company. Acting on reports obtained from Government geologists and from an independent mining engineer, Mr. Wm. Poole, at one time director of the Charters Towers School of Mines, the Government exercised its option, and bought the mines for £40,000, the royalty payable under the tribute and certain moneys which the Government had spent in connexion with the mines being deducted from the purchase-price. Previously the State was debarred from acquiring these mines by a stipulation insisted on by the Opposition in Parliament in the Act which authorized the purchase by the Government of the Chillagoe railways and smelters, but after the Ministry had secured a majority in the Legislative Council by the appointment of a number of their supporters to positions in that chamber, they were able to pass an amending measure giving the Government practically unlimited power with respect to the acquisition and working of the mines in connexion with their enterprises in the Chillagoe district.

THE STATE SMELTERS.—Although metal market quotations have continued to fall, ore is being received at the Chillagoe State smelters, apparently with a view to an early re-start, notwithstanding that metals have accumulated to the value of some £100,000 awaiting an improvement in the market. The quantity of ore received at the works in April was 2,600 tons of silver-lead ore, estimated to contain 28,850 oz. of silver, 310 tons of lead, and 9 tons of copper; and 605 tons of copper ore, containing 31 tons of copper, 1,332 oz. of silver, and 13 oz. of gold. In the last financial year these smelters made a loss of £27,000.

HAMPDEN CLONCURRY COPPER MINES.—The smelters of the Hampden Cloncurry Copper Mines, Ltd., which, like the two other copper mining companies operating in the Cloncurry district, did no productive work last year, still remain idle, and the manager of the company recently stated that there is no possibility of operations being resumed until wages and other working costs have been reduced. The company is asking the Government to concede a reduction in railway freights (a very important item in the Cloncurry district,

which is some 500 miles from port) and to make provision at the Bowen coalfield for the manufacture of coke for the Cloncurry smelters, but nothing in these directions has yet been done. As one of the other Cloncurry companies—Mount Cuthbert—did not fall in with a proposal of the Minister for Mines for a conference to consider, among other things, the question of coke-making at the Bowen coalfield, it is not likely that a coking plant will be installed there, at any rate, for the present. The Government will get coke for their Chillagoe smelters from the Mount Mulligan coalfield, which is only about 90 miles distant by rail, while to obtain it from the Bowen field would mean two long railway journeys and water carriage from Bowen to Cairns. An up-to-date coking plant is now approaching completion at the Mount Mulligan colliery. The Hampden Cloncurry Company, however, is employing sixty men in developing the Trekelano mine, with the intention of raising 10,000 tons of ore to form a reserve to be utilized when the normal output of the company's mines, when smelting is resumed, fails to meet smelting requirements.

Arsenic Production.—At the State arsenic mine at Jibbenbar, which had closed down some time before Christmas because supplies had exceeded the demand, operations have now been resumed, and a clean-up about to take place is expected to yield 200 tons. Since the closing down, the mine has been more fully developed, while the machinery has been improved and is now working at its full capacity, with the result that, according to the Minister for Mines, fewer men are employed with no reduction in output and that costs have consequently been reduced. It is stated be to the intention of the Government to adopt some systematic method for the disposal of the product of the mine, and it is not unlikely that a plant will be installed for the manufacture of prickly-pear poison ready for use, instead of selling the arsenic in its raw state, as heretofore. It now seems that the Government is to have a competitor in the arsenic business, for it is announced that a private concern which has been manufacturing prickly-pear poison in New South Wales, and owns an arsenic mine near Ballendean, in the same district as Jibbenbar and in the vicinity of the southern Queensland border, is about to develop its mine and erect treatment works on the border at Wallangarra, with the view of distributing the product in both Queensland and New South Wales.

VANCOUVER, B.C.

June 5.

Granby Consolidated.—The Granby Consolidated Mining Smelting & Power Company issued its annual report for the year ended December 31, 1921, at the end of May. The deficit on the year's operations, after allowing $300,000 for depreciation, was $287,161. The gross revenue from operations was $7,234,519; the operating cost was $6,309,214, leaving a net revenue from operations of $925,305, to which must be added dividends from investments amounting to $66,796, bringing the total to $992,101; administrative and general expenses, insurance, taxes, discount, and exchange, and interest on bonds and bank loans amounted to $979,262, leaving a net profit before the deduction for depreciation of $12,162. Considering that the average price at which the company sold its copper during the year was only 12·76 cents per pound, the financial statement cannot be considered as other than exceedingly satisfactory, and that it is so considered on the market is evident from the fact that the common stock advanced from about $28 to $34 almost immediately after the report was published.

From a metallurgical view-point the report is highly satisfactory, as it shows that the average cost of production of copper at Anyox during the year was 11·63 cents per pound, compared with 15·94 cents in 1920, a reduction of 27%. This reduction is attributed to marked improvement in metallurgical practice and to the loyalty of all employees in accepting reductions in salaries and wages rather than see the plant close down.

During the year 913,008 tons of ore was passed through the smelter, together with 319,756 tons of matte and furnace cleanings, 126,780 tons of fluxes, and 54,961 tons of coke. From this charge was produced 29,970,651 lb. of copper, 493,283 oz. of silver, and 8,838 oz. of gold. In 1920 the company produced 25,744,327 lb. of copper, 1,054,206 oz. of silver, and 9,418 oz. of gold; three-quarters of the silver production, however, was obtained from custom ore, principally from the Dolly Varden mine.

Owing to metallurgical improvements at both the smelter and at the coke-oven plant, considerably less coke was used than in

previous years, and, consequently, the coke-ovens were operated at only 43% capacity. From 89,543 tons of coal that was charged into the ovens 56,021 tons of coke, 2,193,555 lb. ammonium sulphate, 661,046 gallons of tar, 188,901 gallons of refined motor fuel, and 137,000 M. cu. ft. of gas was obtained. The company's Cassidy colliery, on Vancouver Island, produced 215,211 tons of marketable coal, of which 89,529 tons was used at the company's smelter and mines and the remainder was sold.

No capital expenditures of importance were made during the year; the directors recommend that during the present year a new reservoir and additions to the existing power plant be made and a 1,000 ton concentrating plant be erected at Anyox, to treat siliceous ore of too low a grade for profitable pyritic smelting. The former improvement already is well under way, and it is estimated that when finished it will effect an annual saving of between $150,000 and $200,000. The work is being financed by a new issue of 30,000 shares of treasury stock at $25 each, the whole of which has been subscribed by the present stockholders in the company. It is not known when work on the new concentrator will be started, but the experimental plant that has been in operation at Anyox for some years has demonstrated that the siliceous ore surrounding the bodies of smelting ore at Hidden Creek mine is amenable to treatment by flotation.

Consolidated Mining and Smelting.—At a special meeting of the shareholders of the Consolidated Mining & Smelting Company, which was held at Montreal on May 30, the issuing of $7,500,000 of convertible refunding debenture seven per cent bonds was approved. The debentures are to mature on July 1, 1942, and may be exchanged at any time for fully paid shares in the capital stock of the company. At the present time only £6,000,000 will be issued, and one million of this will be used for the construction of the first 2,500 ton unit of the concentrator to treat the Sullivan mine ore. This plant will be built at the mine. The plans are ready, and construction will be commenced immediately. As soon as it is finished the plant at Trail, which now is used for treating Sullivan ore, will be used to concentrate the ores from the company's Rossland mines.

Slocan District.—The flotation department of the concentrator at the Silversmith mine, in the Slocan district, was put into operation in the middle of May, and the plant is producing a 50% zinc concentrate containing about 35 oz. of silver per ton at the rate of 400 tons per month. The gravity section of the plant is producing a similar amount of silver-lead concentrate, running about 70% lead and 106 oz. silver per ton. Besides the concentrates the mine is shipping about 100 tons of crude high-grade silver-lead ore. Under the new zinc schedule at Trail it is estimated that the zinc concentrate will yield the company $23 net per ton. Previously there has been no market for this class of concentrate; in fact, there is some 2,000 tons that was produced by the Silversmith company's old mill, which has been on the dump for several years. This will be collected and sent to Trail.

Premier Mine.—H. A. Guess, vice-president and managing director of the Premier Gold Mining Company, has just returned to Victoria from his semi-annual visit to the mine. He stated that another dividend would be disbursed at the end of June, but was not prepared to say what the amount would be. The mine has been producing steadily, and it is not likely that the dividend will be less than that distributed on March 31, namely, $500,000 on the capital stock of 5 million. While in the north Mr. Guess, on behalf of the company, took a three-years' bond on the Northern Light group of eight full claims and two fractions, which are situated immediately north of the company's present holdings. The consideration was $125,000, and the agreement calls for certain work being done. A cash payment of $5,000 was made. A violent wind storm on May 21 blew a number of trees across the Premier ropeway, and put it out of service for two days, but no serious damage was done to the line.

A. B. Trites, of Fernie, one of the original syndicate that started to develop the Premier mine and one of the principal shareholders of the company, and New York associates have taken a bond on the Big Missouri, which is situated about 6 miles higher up the Salmon River than the Premier. This mine was bonded for about two years by Sir Donald Mann and associates, who formed the Pacific Exploration Company to develop it. The property contains some enormous belts of low-grade ore, that had been exposed by surface-stripping, and the Pacific Exploration Co. did several thousand feet of diamond-drilling, and a considerable amount of surface trenching and tunnelling, the outcome of which was said to be that the immense

exposures on the surface, some of them over 1,000 feet in width, did not persist in depth, and the bond was relinquished. With regard to this development, George Clothier, resident Provincial Mining Engineer for the district, says in the last annual report: "I think that after proving the surficial nature of the deposit more lateral drilling should have been done through the ridge and across the trend of the intruding mineralized quartz-porphyries, to prove whether or not there are any such dykes coming up to the flat ore-zone now remaining on the surface. Shear-zones along the contact of these quartz-porphyries with the intruding tuffs are proving to be bonanza enrichments in the Premier mine."

More miners and prospectors are at work in the Portland Canal division than at any time since mineral was first discovered in the district, and examining engineers, representing big United States concerns, are arriving on nearly every boat to look over the district and to see if anything of promise is to be picked up.

CARIBOO.—The excitement in the Cariboo has been dampened to some extent by the lateness of the season. Many who came to the field were green prospectors, and sitting around waiting for the snow to melt killed their enthusiasm. Still, a large number have remained, and several properties have changed hands. The Stephens & Sheridan claims, adjoining the Platt & Lyne discovery claims on Cedar Creek, were sold recently, it is stated for $200,000. Representatives of the buyers made the sworn statement that the gravel was running more than one ounce per cubic yard and that on May 29 they rocked out 8 oz. 16 dwt. from one yard of gravel.

TORONTO

June 12.

METALLIC PRODUCTION OF ONTARIO.—Returns of metallic production received by the Ontario Department of Mines for the three months ended March 31 give the total value of the output as $7,227,322, as compared with $5,626,779 for the corresponding months of 1921. Gold was produced to the amount of 226,176 oz. of the value of $4,675,475, as compared with 111,096 oz., value $2,296,522; and the output of silver was 2,958,094 oz., valued at $1,980,099, as compared with 2,106,045 oz. and $1,226,551 for the first quarter of 1921. According to preliminary estimates the production of gold for the month of May was upwards of $1,735,000, and the output of the silver mines of Cobalt and the outlying districts was approximately 740,000 oz. of silver. The activity of the mining industry has given a great stimulus to prospecting. Officials of the Provincial Department of Mines state that there are now more prospectors at work in Northern Ontario than ever before, and they anticipate that the widespread search will lead to some important discoveries.

PORCUPINE.—The eleventh annual report of the Dome Mines for the year ended March 31 shows a great increase in production and earnings. Net profits were $1,244,922, as compared with $302,479 in the previous year and $951,984 for the year before that. A total of 360,000, tons of ore was milled which yielded bullion worth $2,809,452, the average yield per ton being $7·80. General Manager Depencier stated that the ore-bodies opened up proved so irregular in form and content that no satisfactory estimate of ore reserves could be based on exposures in drifts and cross-cuts. The work of development is being rapidly pushed by a force of 550 men, and further large tonnages have been placed in sight at the 1,000 and 1,150 ft. levels. A station is now being established at a depth of 1,600 ft. The grade of the ore now being treated is stated to run from $12 to $15 per ton.

The new mill unit of the McIntyre is expected to be in operation before the end of June, increasing the capacity of the plant to upwards of 750 tons daily. An important feature of recent development work has been the discovery that a porphyry intrusion at depth has so altered the course of one of the main ore-bodies that instead of crossing the boundary into the Hollinger property it remains in the McIntyre a quarter of a mile further than was supposed.

Diamond-drilling on the Davidson Consolidated has discovered an ore zone at the 1,200 ft. level. A width of 25 ft. is indicated. Work has been resumed on the Clifton-Porcupine, where a new vein 3 ft. wide carrying visible gold has been discovered on the surface. Plans for a new mill have been prepared. At the Premier Paymaster a station has been cut at 300 ft. for the development of an ore-body encountered in the shaft. Sinking will be continued to 415 ft. The Coniagas of Cobalt has secured a controlling interest in the Newray property and agrees to expend $4,000 per month in development. Exploration work on a large scale will be

done by diamond-drilling. Sinking operations are under way at the Porcupine Vipond-North Thompson, where the shaft is being put down from the 600 ft. level, on which lateral work is being done. The area between the main vein and the Hollinger boundary is being explored by diamond-drilling. The Goldale, recently taken over by the Lewisohns, of New York, is being actively developed.

KIRKLAND LAKE.—The mill of the Tough Oakes is now in steady operation, the chief source of ore being the main break at the 400 ft. level. A cross-cut is being run at a depth of 650 ft. to tap the downward continuation of the main vein. The Teck-Hughes during May treated 4,840 tons of ore with mill-heads running about $10 per ton. A new vein has been found on the 730 ft. level having a width of about 6 ft. and is being opened up. The main shaft of the Kirkland Lake mine is being put down from its present depth of 900 ft. Levels will be opened up at 1,050 and 1,150 ft. Milling is at present considerably below capacity pending further development. At the Wright-Hargreaves lateral work is in progress on the 700 ft. level to develop a rich vein found in sinking the shaft. Surface work is under way at the Canadian-Kirkland, where a shaft is already down 150 ft., which will be continued to a depth of 300 ft. There are two exceptionally strong veins outcropping. The Bidgood is developing some rich ore at the 400 ft. level. The King-Kirkland, which has been driving in good ore at the 100 ft. level, has let contracts for sinking the shaft from that depth to 300 ft. A number of claims have recently changed hands. New York interests have taken over a group of four locations near the Tough Oakes. The Monroe-Kirkland group of claims east of the Lebel Lode properties has also been sold to an American syndicate. The Kitchener-Kirkland has purchased the five Wessell claims adjoining their holdings, half a mile north of the Wright-Hargreaves property.

COBALT.—The annual report of the Mining Corporation of Canada shows a net loss of $503,987, due to losses on optioned property and other outlays apart from its Cobalt enterprises. The total production of silver was 1,226,716 oz., as compared with 1,664,018 in 1920. Ore reserves are estimated at 1,935,745 oz. The report indicates that while the original Cobalt holdings are gradually becoming exhausted the Corporation is actively seeking new sources of income, having investigated 107 new properties during the year. Properties in South Lorrain have been taken over under option and eight gold claims staked in the Lightning River district.

The Nipissing during April mined ore of an estimated net value of $185,511, shipped bullion of an estimated net value of $136,450, and produced 30,425 lb. of cobalt. The Bailey customs mill during May treated 3,237 tons of ore, its approximate gross earnings being $9,731. At the Victory a well mineralized vein has been encountered in the shaft near the contact between the Keewatin and diabase formations. The McKinley-Darragh is in full operation, and the Peterson Lake and Dominion Reduction Co. are preparing to resume work.

ELBOW LAKE, MANITOBA.—There is great activity in this new gold camp, where hundreds of claims were staked during the winter, and prospectors are now busy on their holdings. The Murray property, now being developed by the Hollinger interests under option, is showing up extremely well. The Exploration Co., Ltd., of London, have options on a number of claims at and near Elbow Lake, and have parties of men carrying on development work. Many new discoveries in various parts of the district are reported. Among prominent Eastern mining men visiting the camp are Major Julius M. Cohen, of Montreal, and President Noah A. Timmins, of the Hollinger Consolidated.

SOUTH AFRICA

June 12.

A DIAMOND RUSH.—The diamond rush on the Vaal River, 60 miles west of Kimberley, has been the excitement of the month, and a particularly healthy one after the general run of destructive or retrograde incidents by which our mining history has been marked of late. The new diggings at Mosesberg, at the close of a long tale of litigation and public agitation, were proclaimed on June 9. A few thousand diggers, and others, took part. Owing to a certain amount of bungling in the arrangements, the peggers did not commence their rush at 11 a.m. like a wave of troops springing to the attack, but advanced in batches according to their own interpretation of the Proclamation signal or understanding of the time. The raggedness of the advance caused this rush, perhaps the last to be made under the old principle, to be a disappointing

affair for those who wished to see speed and conflict. However, the net result has been the same. All the Mosesberg alluvial deposit, the farthest down-stream of any along the banks of the Vaal, has now been pegged, and will rapidly add its quota to the yield of river stones. The deposit belongs to an ancient river system and is to the west of the present river channel.

It is an open question whether the antiquated system of the rush will be followed in future. A ballot on the diggings would be safe and fair, though it would necessarily mean that claims would fall less into the hands of experienced diggers, and be won largely by the people with transport facilities who would visit the area of proclamation for the mere gamble of drawing a lucky ticket. It is probable, however, that a lottery on the ground, followed by demands for a small measure of assessment work to be done within a month, would speedily result in all the ground falling into the hands of the bona-fide diggers, a class it is naturally desirable to assist, but not to increase in numbers.

Crown Diamonds.—The reconstruction of the Crown Diamond Mining and Exploration Co., Ltd., operating the old Lace mine, gives interest to a proposition long believed to be dead. There is no doubt that the prospects of the mine have improved since Messrs. Lewis & Marks extended development in the western section and in depth, but it cannot be claimed that the consulting engineer's report is explicitly favourable. The report—a description of complex geological conditions without a plan—conveys two impressions. Firstly, that the Crown or Lace mine must be worked selectively to maintain a grade of 10 carats. Secondly, that total costs must not exceed 2s. 6d. per load to balance accounts. If the company can to-day maintain the selective or clean-blue yield at the total expenditure estimated, it will be a creditable achievement.

West End Diamonds.—The brighter prospects of the diamond industry, leading to an increased interest in Johannesburg in diamond ventures, must not tempt speculators to think favourably of mines or would-be mines found lacking in the boom days of 1919–20. To warn a man who dabbles in diamonds that he should be "careful" would be like cautioning an African explorer against fever and mosquitos, essential factors in the game. But it is, at least, reasonable to urge him to discriminate between prospects with unknown chances and new ventures that have developed unfavourably. Last month the Postmas mine and the Makganyene were classified under the latter head, and a warning was given in general against the 1920 ventures of the Postmasberg district. This unfavourable view has not been modified by the Chairman's speech at the meeting of the South African Townships Mining and Finance Corporation, Ltd., wherein the prospects of the West End Diamond mine were reviewed. This Postmasberg property is represented to have a true mine grade, below the mixed limey deposit, of at least 10 carats per 100 loads, while difficulties with plant and admixture of lime in the shallow ground explain the present yield, reported at 8 carats. No confidence can be placed in suggestions of improved yield unless an explanation is forthcoming of the character of this superficial limey deposit, of its relation to the deposit (indicating its part as an impoverisher instead of an associate of the usual surface enrichment), and of the extent of deeper and cleaner tests, by which the hopes of shareholders are raised.

Far West Rand Development.—The Coronation Syndicate continues to report payable assays from bore-hole intersections on Luipaardsvlei 10, south of the Randfontein area. The correlation of reefs is, for the time being, unimportant if consistent payability can be indicated. Undoubtedly the western extension of the Rand will be developed extensively as soon as industrial confidence is restored. In spite of the bore-hole results published years ago by the Western Rand Estates, the hidden Witwatersrand formation between Randfontein and Klerksdorp is a riddle of great interest, which can be solved only by speculative capital and good engineering.

Mining Commission's Progress.—Measured in words, the progress of the Mining Industry Board has been remarkable. Opinions of all interests and parties have been poured into their proceedings. Both enterprise and labour (to modify the usual capital–labour subdivision of industry) have placed their faith in verbal steam-rollers as weapons of conviction. To those of us seeking a foresight of the results of the deliberations, beyond the release of pressure attributable to the exercise of all safety valves, no measure of enlightenment has come. We only know that each of the Commissioners

(excluding the board's most distinguished and open-minded chairman) commenced his inquiry with sympathies and convictions too deep-rooted to be affected by technical arguments to-day. From the start, we have seen Mr. Brace committed to compulsory unionism, even on the Rand, where unionism has failed so lamentably. We have seen Sir Robert Kotze committed to a policy of compromise, essential to his office and functions as Government Mining Engineer. We have seen Sir Carruthers Beattie committed to fanciful academic ideals, of communistic tendency, toying with algebraic problems in the distribution of cash assets, unmindful or ignorant of the greater urgency of the creation of new wealth in a young and developing country.

CAMBORNE

July 4.

HELP FOR THE UNEMPLOYED.—The tide of unemployment in Cornwall does not abate much, but there are signs of a revival in tin mining and the china clay industry. A few mines are getting their houses in order and employing labour, so that with an improvement in trade generally it is confidently hoped that the day of full employment may not be far distant when Cornwall will come into its own again. The future may be safely left to look after itself, but the present must needs be provided for, especially as there are something like 3,000 men idle in Redruth and Camborne alone, to say nothing of their families. The Chief Constable of Cornwall, Lieut.-Col. Protheroe Smith, has raised £10,000 towards the relief fund and the local police have done yeoman service in providing destitute families with food, clothing, and boots, which they have collected. The sources of relief in cash and kind have been numerous, but funds are now getting exhausted. The Government dole is of an intermittent nature, and the local guardians are taxed to the utmost to make scant provision. There is now apparently a rift in the clouds, and a determined effort is being made to resuscitate the industry, with some degree of success in a few quarters. Here and there prospecting of a private nature is being carried out by a few unemployed and others, but the biggest effort in this direction is being made on the North Treskerby section of the old Scorrier Consols mine. Backed up by capital subscribed by members of various religious bodies, a few men are engaged on reopening this property. North Treskerby in the past was worked principally for copper, having yielded over 22,000 tons of copper and copper ore and 1,300 tons of black tin. A steam winch has been purchased and headgear erected, and with the help of other plant lent by sympathetic friends it is proposed to clean the adit (45 fm.) and upper levels with a view to their inspection by a competent mining engineer before proceeding further. It is reported on favourably and hopes are entertained that the venture may be the precursor of further undertakings of this sort.

THE CHAMBER OF MINES.—The Cornish Chamber of Mines held its annual meeting on June 16 at the Camborne School of Mines under the chairmanship of Mr. Oliver Wethered, that staunch supporter of Cornish mining. The report for the year ended December 31 last draws attention to a period of almost complete stagnation in the mining industry of Cornwall. The suspension of most of the mines and the consequent unemployment and distress of 3,000 miners and their families has been due to abnormal economic conditions, but with a general improvement in trade there is a distinct hope for a revival of the tin mining industry. As Mr. Wethered says: "Though we are not out of the wood we can see light through the tree tops." The work of the Chamber during the period under observation grapples with the question of the rating of mines during the period of suspension of operations. Claims are being made as usual, and appeals have been made against the assessments. The Council has taken up the cudgels and has arranged with its solicitors to state a case for the High Court under the Baines Act. The Chamber has taken over the unexpected balance of the tin and tungsten research board held by the Imperial Trust which is to be applied for the encouragement of research into tin and tungsten recovery. A feature which reflects strongly against the Cornish mining industry is the freightage for coal into the county. Coal can be purchased in Somerset at 12s. per ton, and the carriage to Carn Brea station is 15s. per ton. Efforts have been made by the Council during the year to induce the railway company to reduce these disproportionate charges, but the company was unwilling to make any reduction. During the year the Council has written the Trades Facilities Act Committee commending the various applications for guaranteed loans after giving the same

very careful consideration. The Council has hopes that their intervention may have a useful influence.

EAST POOL.—The new shaft that is being sunk to the north of Wheal Agar is now down 500 ft., and is making record progress. During the month of May they sunk 133 ft., including timbering and the cutting of all necessary hitches and stations for the pumping plant. This probably constitutes a record in sinking. The "country" is killas and the shaft is 18 ft. by 7 ft. within timbers. There are eight men per shift of six hours. The turf was cut on January 12 of this year, and allowing for the greater part of January being spent in preliminaries and getting into stride this brings the sinking average to 100 ft. per month. A band of greenstone is now being traversed and progress must needs be slower until it is cut through. As over 130 drills require to be sharpened per shift, the hard character of this rock will readily be appreciated. Erection of the winding engine is proceeding apace, and the Lancashire boiler is in its sitting. The 120 ft. fire-brick lined chimney stack is under construction, as also is the main headgear. There are many excellent devices for speeding up and labour-saving, and the whole lay-out augurs favourably for the future. About one hundred men are employed.

SOUTH CROFTY.—The new engine house for the 90 in. Cornish pump is a massive building of reinforced concrete with a brick-lined concrete stack forming an integral part of the main structure and finishing in brick-work above the house. The engine, bought from Grenville, is now delivered on the mine, and erection is to proceed at once. It will be remembered that this additional pumping plant is necessitated by the influx of water from the abandoned workings of East Pool and of Tincroft adjoining. The formidable character of the undertaking may be gathered from the fact that the cylinder is 90 in. diameter, and the cast iron beam for actuating the pump rods in the shaft weighs nearly 45 tons. A 20 in. steel column is to be erected in the shaft for the discharge of the water. Two Lancashire boilers are on the site for the supply of steam. About one hundred and thirty men are employed and every effort is being made towards an early resumption of mining operations, which it is hoped may take place by the end of this year or the beginning of next.

KINGSDOWN MINES.—This mine at Hewas Water, near St. Austell, which has its registered office in London, is vigorously forging ahead towards the producing stage. The main shaft is now down 300 ft., and about a mile of levels have been driven on the five main lodes already proved. About 2,500 tons of ore is at surface and a goodly quantity is blocked out for stoping. The mill is to be erected without delay, capable of treating 3,000 tons per month. The tin concentrate produced from this ore carries the high metal content of 70%. The whole sett comprises Kingsdown, Ventonwyn, and Wheal Elizabeth, all adjoining and to the west of Great Hewas, an old mine of renowned producing ability. About fifty men are at present employed underground.

SOUTH TERRAS.—This mine, owned by the Société Industrielle du Radium, registered in London, has now completed its plant, where the radio-active ores are to be treated for their radium content at the commencing rate of one ton of ore per day. The mine is situated in a wet valley, and up to the present it has been the policy to pump and mine ore during the dry season of the year in sufficient quantity to carry them over the winter. The mill where dry crushing is in vogue is capable of dealing with 6 tons per day, and it is intended to eventually increase the extraction plant to this capacity. There are in store about 200 tons of crushed ore ready for chemical treatment containing 2,500 milligrams of radium, which it is hoped to recover by the end of the year. Pumping and mining operations re-commence this month.

GIEW MINE.—This mine, situated near St. Ives, enjoys the unique position of having been a regular producer of black tin throughout the period of depression and still returns the usual average of about 5 tons per week of black tin to the smelter. The main shaft is down to 217 fm. below adit (30 fm.). The water is raised by electric pumps, current being supplied by the Cornwall Power Co. from their works at Hayle, and the mill and surface works as well as hoisting are actuated electrically from the same source. In view of the enhanced cost of current, labour, and materials the continuance of this mine under such unfavourable auspices exhibits a careful and praiseworthy control. When better times prevail it is proposed to sink a new shaft to open up additional proved lodes in new ground. About one hundred and ten men are employed.

GEEVOR TIN MINES.—This St. Just mine has commenced preparatory work for the

unwatering of the Victory shaft in order to resume development from this to the Pig lode. The mine is being kept drained by means of electric pumps and sufficient ore from reserves is brought to surface where it is milled during the morning shift of each day. About sixty-five men are employed. Electric power for all operations is supplied by the Cornwall Power Co., Hayle.

LEVANT TIN MINES.—This mine, also at St. Just and adjoining Geevor, sticks to its guns with bull-dog tenacity. Stoping and developing are in progress about the 170 fm. level, and good headway is being made with the reconstruction scheme. Owing to the man-engine disaster and the war this mine has for some time been under a cloud, but due to the untiring efforts of Colonel Oats there is every prospect of its resuming the glories of its past.

CHINA CLAY.—A new china-clay area is being opened in Towednack parish, near St. Ives. Plant is now being erected to work this, and the clay is stated to be of excellent quality.

PERSONAL

H. FOSTER BAIN is visiting Alaska.

STUART BROWN is home from Nigeria.

A. G. BURROWS, of the Ontario Geological Survey, is to make an examination of the Porcupine district.

J. M. CAREY has been appointed Inspector of Mines for the South Wales Division.

LOUIS S. CATES has been appointed general manager of the Utah Copper Company.

D. T. CHADWICK, Indian Trade Commissioner in London, is returning to India, and his place in London will be taken by H. A. F. Lindsay, at present Secretary to the Department of Commerce in India.

Sir DUGALD CLERK has been awarded the Albert Medal of the Royal Society of Arts.

Dr. A. P. COLEMAN is resigning as head of the department of geology in Toronto University.

STANLEY H. FORD has returned from West Africa.

ARTHUR FRANCIS has left on his return to West Australia.

R. T. HANCOCK has left for Venezuela.

A. L. HAY has been appointed general manager of the Misima gold mines, Papua.

JOHN HENDERSON is on his way back to the Lahat mines, Federated Malay States.

ELLWOOD HENDRICK is here from New York.

C. T. HEYCOCK, Goldsmiths' Reader in Metallurgy in Cambridge University, has been appointed Prime Warden of the Goldsmiths' Company.

A. W. HOOKE has left for America.

J. R. HORSLEY has left for Prestea Block A.

Major PERCY S. INSKIP has been appointed general manager for the British South Africa Company in South Africa, with headquarters at Salisbury. He has been connected with the company for over thirty years.

A. E. KITSON, Director of the Geological Survey of Gold Coast Colony, has been made C.M.G. He is at present on a periodical visit to this country.

C. W. KNIGHT, of the Ontario Geological Survey, is to make an examination of the South Lorrain silver district.

Dr. J. MALCOLM MACLAREN is back from Venezuela.

VISCOUNT MILNER has been elected chairman of the Rio Tinto Company in succession to Sir Charles W. Fielding, who will devote his entire attention in future to the technical and producing side of the company's business. Sir Arthur Steel-Maitland continues as managing director.

JACK PICKERING has returned to the Klondyke.

R. C. RILEY has gone to Kamptee, India, for the Central Provinces Prospecting Syndicate, Ltd.

W. ROWE has left for West Africa.

GORDON THOMSON has left for West Africa.

A. J. TRAVIS is leaving for Colombia.

E. C. VIGEON is visiting the United States.

A. T. WATSON has returned from the Gold Coast.

A. WEINBERG is here on a visit from the Klondyke.

ERNEST SOLVAY, the inventor of the ammonia-soda process for the manufacture of carbonate of soda from brine, died at Brussels on May 26, aged 84.

T. R. ARCHBOLD died in New Caledonia last month. He was a graduate of Camborne School of Mines, and his first position was with the Copiapo copper mines in Chile. Subsequently he was an examining engineer for the Tharsis Sulphur and Copper Co. Afterwards he went into partnership with Dr. T. R. Marshall, and in his capacity of consulting engineer examined a great many properties in various parts of the world. In 1910 he was appointed general manager for the Chrome Company, Ltd., at Tiebaghi, New Caledonia, a position which he held until his death.

G. R. BONNARD died on July 1. He was a well-known promoter of mining and other ventures in London, and in his time placed much capital to advantage. He will be remembered for his association with the lawsuit of the Amalgamated Properties of Rhodesia against the Globe and Phœnix, a case which lasted for 144 days in the Chancery Court, and in which the American-based mining law of Rhodesia puzzled judges and counsel alike, in this Court, in the Court of Appeal, and in the House of Lords. His last important work was in connexion with the reorganization of the Kirkland Lake Proprietary, a stroke of finance that should prove helpful in the development of Ontario gold-mining operations.

TRADE PARAGRAPHS

THE DENVER ROCK-DRILL MANUFACTURING CO., of Denver, Colorado, send us a pamphlet describing the Waugh-Sinclair Portable Air-Compressor.

The Draper Coal Washer, made by the RHONDDA ENGINEERING AND MINING CO., LTD., Bridgend, South Wales, is described and illustrated in *Engineering* for June 2.

TROST BROTHERS, of 26, Little Park Street, Coventry, send us a circular describing their "Rotameter," an apparatus for measuring the air consumption of pneumatic tools.

THE CASSEL CYANIDE CO., LTD., of Glasgow, send us a pamphlet giving full instructions in connexion with the case-hardening of articles made of mild steel by means of a sodium cyanide bath.

The Hyatt roller bearings, made by HYATT, LTD., of 56, Victoria Street, London, S.W. 1, as applied to iron and steel works equipment, are described in the *Iron and Coal Trades Review* for June 2.

THE SWEDISH DIAMOND ROCK-DRILLING CO., of Stockholm, send us an elaborate illustrated pamphlet of 100 pages describing their system of diamond-drilling, with full instructions as to the method of working.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, have issued a pamphlet entitled "Drill Data," which gives a history of twist drills and hints how to use them correctly, together with practical notes on grinding.

THE CONSOLIDATED PNEUMATIC TOOL CO., LTD., of 170, Piccadilly, London, W. 1, send us Catalogue 12E, which contains an elaborate account of their Little Giant electric drills for all purposes, including drills for the mine and quarry. They also send Circular No. 78 relating to their electric rivet-heater.

THE HARDINGE COMPANY, of New York (London office: 11, Southampton Row, W.C. 1), are the London agents for the W. S. Tyler Company, of Cleveland, Ohio. They send us Catalogue 36 describing the Tyler testing sieves and Catalogue 42x dealing with the Hum-mer electrically-vibrated screens.

THE INGERSOLL-RAND COMPANY, LTD., of 165, Queen Victoria Street, E.C. 4, send us a copy of their sectional catalogue, dealing with air-compressors, vacuum pumps, condensers, oil and steam engines, Cameron pumps, air-lift pumps, rock-drills, drill-sharpeners, pneumatic tools, tie-tamping outfits for electric railways, etc.

FREDERICK BRABY & CO., LTD., of Petershill Road, Glasgow, have issued a new catalogue relating to their "Eclipse" steel tanks, coal bunkers and ore-bins, troughing for conveyors, oil-fuel containers, etc. They also send us catalogues relating to their stock-room bins, steel buildings and similar structures, and corrugated iron buildings and windows for the same.

ADAM HILGER, LTD., of 75A Camden Road, London, N.W. 1, send us a pamphlet relating to their new spectrographs adapted for metallurgical analysis. This is used for recording the spectra of metals, alloys, etc., and its application is the detection of the presence of various metals with greater certainty and rapidity than is possible by chemical analysis. A characteristic example of the method is given in the pamphlet, where cadmium and copper are shown to be present in the purest lead obtainable for assay purposes.

THE SULLIVAN MACHINERY CO., of Chicago (London office: Salisbury House), send us a number of new and revised bulletins as follow: 69M, the Sullivan Diamond Core Drills; 70X, the Sullivan Spader, or spade driven by compressed air; 77D Sullivan Portable Air-Compressors; 79C, Sullivan Ironclad Coal Cutters for room and pillar and long-wall mining; 79D, Sullivan Ironclad Coal Cutters for room and pillar mines; 79E, Sullivan Long-wall Ironclads; 79F, Motors, Driving Gear, Cutters, and Feed for Sullivan Ironclad Coal Cutters.

The SUPER-VICE CO. (H. F. Bateman, proprietor), of 172, Bishopgate, London, E.C., send us a circular relating to the Super-Vice, of which the following are characteristic points: Vertical work one third the total jaw width can be gripped. The vice has a patent whole nut in the quick release action. The whole nut grips the main screw all round, yet releases instantly when required. The vice has solid, rolled, unbreakable, high-tensile-strength, steel slides. The body of the vice is in one unjoined piece, accurately machined to fine limits. The jaws are high and sloping to allow of filing angles on small springy work. Each part of the vice is interchangeable; replacements are immediately available. The detail finish is tool-room finish and the strength of the vice is backed by guarantee.

METAL MARKETS

COPPER.—Minor fluctuations were seen in values on the standard copper market in London during June, the tendency on balance being rather easier. The somewhat erratic movements of the sterling-dollar exchange naturally influenced the course of prices to some extent, while the dullness of the copper trade in this country was a weakening factor. Market sentiment, which stood plainly in need of a fillip, was cheered by strong reports from America, where the industrial position has improved considerably, and the copper market at one time assumed a firm tone. Subsequently, however, it was adversely affected by various unfavourable events, such as the finding of the Banker's Conference regarding a loan to Germany, the signs of possible trouble in that country, and the renewed disturbances in Ireland. English consuming industries have perhaps undergone a little change for the better, and it was noticeable during the month that Continental competition in finished copper products was rather less keen, which encourages hopes that in the near future this country may be able to secure a larger proportion of the business available than at present. At the opening, the American market for electrolytic advanced to about 14 cents, but as the month wore on, an easier tendency manifested itself. Although no serious weakness was observable over there, the cent price closed rather lower on the month at 13¾. There seems little likelihood of the American position sustaining any substantial setback for some time to come, despite the increasing activity of the mines and refineries, since producers have the situation well under control.

Average price of cash standard copper: June, 1922, £62 0s. 11d.; May, 1922, £61 2s. 9d.; June, 1921, £71 18s. 2d.; May, 1921, £73 5s. 10d.

TIN.—In view of the existence of many factors in the situation, which can only be regarded as adverse to the maintenance either of sentiment or values, the steadiness of standard tin during last month was certainly remarkable. Slight variations in quotations occurred, but prices closed the month practically unchanged. Business on 'Change was wonderfully well maintained, and the quantities coming on offer were well absorbed. No selling pressure, however, was evident. A large proportion of the business seems to have been of a professional character, and options were frequently dealt in. A rise seems certainly unlikely under present conditions, while since a large body of opinion holds that ruling prices are reasonable, no substantial decline is to be anticipated. Meanwhile, the Straits have been selling freely, and large shipments were made during the month, which roused expectations of an increase in the visible supplies. These anticipations, however, were not fulfilled, the statistics published at the commencement of July revealing only an inappreciable change in the position. Batavia was

Daily London Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long Ton

Copper

	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
June	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
12	61 7 6 to 61 10 0	61 12 6 to 61 15 0	69 10 0 to 70 10 0	70 10 0	— —
13	61 0 0 to 61 2 6	61 7 6 to 61 10 0	69 0 0 to 70 0 0	70 0 0	66 0 0 to 68 0 0
14	61 7 6 to 61 10 0	61 12 6 to 61 15 0	69 0 0 to 70 0 0	70 0 0	— —
15	61 17 6 to 62 0 0	62 2 6 to 62 5 0	69 0 0 to 70 0 0	70 0 0	— —
16	61 17 6 to 62 0 0	62 2 6 to 62 5 0	69 0 0 to 70 0 0	70 0 0	66 0 0 to 68 0 0
19	62 5 0 to 62 7 6	62 10 0 to 62 12 6	70 0 0 to 71 0 0	71 0 0	— —
20	62 2 6 to 62 5 0	62 10 0 to 62 12 6	69 0 0 to 70 10 0	70 10 0	66 10 0 to 68 10 0
21	61 15 0 to 61 17 6	62 2 6 to 62 5 0	69 0 0 to 70 10 0	70 10 6	— —
22	61 15 0 to 61 17 6	62 2 6 to 62 5 0	69 0 0 to 70 10 0	70 10 0	— —
23	61 10 0 to 61 12 6	62 0 0 to 62 2 6	69 0 0 to 70 10 0	70 10 0	66 10 0 to 68 10 0
26	61 12 6 to 61 15 0	62 0 0 to 62 2 6	69 10 0 to 71 10 0	71 10 0	— —
27	61 10 0 to 61 12 6	62 0 0 to 62 2 6	69 10 0 to 71 0 0	71 0 0	66 10 0 to 68 10 0
28	61 5 0 to 61 7 6	61 15 0 to 61 17 6	69 10 0 to 71 0 0	71 0 0	— —
29	61 12 6 to 61 15 0	62 2 6 to 62 5 0	69 10 0 to 71 0 0	71 0 0	— —
30	61 17 6 to 62 0 0	62 7 6 to 62 10 0	69 10 0 to 71 0 0	71 0 0	66 0 0 to 68 0 0
July					
3	62 10 0 to 62 12 6	63 0 0 to 63 2 6	69 10 0 to 71 0 0	71 0 0	— —
4	62 10 0 to 62 12 6	62 17 6 to 63 0 0	70 0 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
5	62 10 0 to 62 12 6	62 17 6 to 63 0 0	70 0 0 to 71 10 0	71 10 0	— —
6	62 7 6 to 62 8 9	62 16 3 to 62 17 6	70 0 0 to 71 10 0	71 10 0	— —
7	62 18 9 to 63 1 3	63 7 7 to 63 8 9	70 0 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
10	62 17 6 to 63 0 0	63 6 3 to 63 7 6	70 5 0 to 71 15 0	71 15 0	— —

somewhat reserved, but China made some sales. As regards consumption, purchases by English consumers were quiet but of a steady nature, but the Continent showed only a little interest, while American inquiry tended to fall away. There are indications that consumers in the United States are pretty well supplied at the present time, while the coal strike there and the threat of a rail stoppage engendered further caution on their part.

Average price of cash standard tin: June, 1922, £152 12s. 3d.; May, 1922, £150 5s.; June, 1921, £167 12s. 10d.; May, 1921, £177 10s. 8d.

Lead.—The tendency on the London lead market during the month was rather easy, but no actual break in values was seen. The easiness was not entirely consistent, and rallies at times rather beclouded the actual state of affairs. On balance the prompt position lost about 5s., while forward remained unchanged. Consequently the backwardation diminished slightly. Arrivals of lead latterly were rather more generous than was formerly the case, but the market did not receive as much benefit from them as might have been expected, as the bulk of the metal was apparently dispatched to consumers. There are indications that the tightest point has been passed, and quite a large body of opinion holds that the tendency of values must now be surely—if slowly—towards a lower level. The rearrangement of French import duties has recently had the effect of discouraging shipments to that country, and as a consequence works there are believed to be somewhat short of supplies. As regards consumption in the United Kingdom, this appears to be improving, and should expand further now that the engineering dispute is out of the way. Undoubtedly, however, no genuine revival can be seen until the prices of both raw and manufactured lead are down to more attractive levels. The margin in price which represents the cost of manufacture in the case of finished products is generally considered excessive. Possibly there is greater room for reduction in the price of manufactured products than in raw lead itself. Meanwhile, consumers are evincing no great trust in the position and are adhering to their policy of buying from hand to mouth. This attitude is to no small extent responsible for the large backwardation which still exists in the London price of soft lead.

Average price of soft foreign lead: June, 1922, £24 3s. 2d.; May, 1922, £23 16s. 7d.; June, 1921, £22 9s. 1d.; May, 1921, £23 7s. 3d.

Spelter.—Fluctuations in price took place on the London spelter market during June, a small loss being sustained on the month. The position generally underwent little change, and the slight downward tendency was probably due more to the slackness of consumers' demand than any other cause. Ostensibly the Belgian and German makers are maintaining their reserved attitude, but a certain amount of spelter has come in from Norway. Belgium still finds it worth while to turn the bulk of her output into zinc sheets, for which a keen demand exists on the Continent. English producers are now turning out probably about 2,000 tons monthly and were at one time pretty keen sellers; latterly, however, they appear to be a little more independent. America did not feature as a seller to this country, and in view of the fact that her stocks are now down to the reasonable level of 40,000 tons, it seems unlikely that producers there will bother much about exporting just yet. A certain amount of spelter was shipped to the United Kingdom from the big Risdon Works in Tasmania, and it will be interesting to see whether this is the forerunner of larger consignments; the metal in question, however, is not expected to arrive before August. United States interests actually bought on the London market at one time, probably finding the transaction profitable when prices and exchanges were taken into account. The galvanizing, brass, and allied industries in the United Kingdom did not display much activity during the month, but there are signs that consumption is gradually broadening, since despite rather larger imports latterly, stocks are still decreasing.

Average price of spelter: June, 1922, £27 16s. 1d.;

Prices on the London Metal Exchange.

Silver per Standard Ounce ; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	d.	d.	s. d.	June
24 15 0 to 23 12 6	26 0 0	28 2 6 to 27 17 6	151 15 0 to 152 0 0	153 2 6 to 153 5 0	35⅝	35⅝	91 9	12
24 10 0 to 23 10 0	26 0 0	28 0 0 to 27 12 6	150 5 0 to 150 7 6	151 10 0 to 151 12 6	35¾	35⅞	92 1	13
24 10 0 to 23 10 0	26 0 0	27 15 0 to 27 12 6	150 10 0 to 150 12 6	151 15 0 to 151 17 6	36⅛	36⅛	92 6	14
24 7 6 to 23 7 6	26 0 0	27 15 0 to 27 15 0	151 5 0 to 151 10 0	152 5 0 to 152 10 6	36	36	92 4	15
24 7 6 to 23 8 9	26 0 0	27 17 6 to 27 15 0	152 10 0 to 152 12 6	153 10 0 to 153 12 6	35¾	35⅞	92 3	16
24 12 6 to 23 12 6	26 5 0	28 0 0 to 27 17 6	152 12 6 to 152 15 0	153 15 0 to 153 17 6	36⅛	36⅛	93 6	19
24 10 0 to 23 12 6	26 0 0	27 16 3 to 27 15 0	152 7 6 to 152 10 0	153 7 6 to 153 10 0	36⅛	36⅛	94 5	20
24 15 0 to 23 12 6	26 0 0	27 15 0 to 27 12 6	152 7 6 to 152 10 0	153 7 6 to 153 10 0	35¾	35¾	93 3	21
24 15 0 to 23 12 6	26 0 0	27 12 6 to 27 10 0	152 5 0 to 152 7 6	153 5 0 to 153 10 0	25¾	35¾	93 3	22
24 10 0 to 23 10 0	26 0 0	27 10 0 to 27 10 0	152 15 0 to 152 17 6	153 15 0 to 153 17 6	35⅞	35⅞	93 4	23
24 7 6 to 23 10 0	26 0 0	27 12 6 to 27 10 0	152 12 6 to 152 15 0	153 12 6 to 153 17 6	35⅞	35⅞	94 0	26
24 7 6 to 23 10 0	26 0 0	27 15 0 to 27 12 6	152 7 6 to 152 10 0	153 7 6 to 153 12 6	36⅛	36⅛	93 4	27
24 12 6 to 23 12 6	26 0 0	27 12 6 to 27 10 0	152 7 6 to 152 10 0	153 7 6 to 153 10 0	36⅛	36⅛	93 8	28
24 17 6 to 23 15 0	26 5 0	27 17 6 to 27 12 6	151 17 6 to 152 0 0	153 0 0 to 153 2 6	36⅛	36⅛	94 2	29
25 0 0 to 23 15 0	26 5 0	28 0 0 to 27 15 0	152 12 6 to 152 15 0	153 12 6 to 153 15 0	36⅛	36⅛	93 7	30
								July
24 5 0 to 23 12 6	26 5 0	27 17 6 to 27 15 0	154 2 6 to 154 5 0	155 2 6 to 155 5 0	36⅛	36¼	93 5	3
24 0 0 to 23 7 6	25 15 0	28 1 3 to 27 16 3	153 17 6 to 154 0 0	154 15 0 to 154 17 6	36⅝	36⅝	93 2	4
24 0 0 to 23 7 6	25 15 0	28 0 0 to 27 15 0	153 10 0 to 153 12 6	154 10 0 to 154 12 6	36⅜	36⅜	92 7	5
24 5 0 to 23 7 6	25 15 0	28 0 0 to 27 15 0	153 17 6 to 154 0 0	154 12 6 to 154 15 0	35⅞	35⅞	92 5	6
24 5 0 to 23 8 9	25 15 0	28 2 6 to 27 17 6	154 5 0 to 154 7 6	155 0 0 to 155 2 6	36	36	93 0	7
24 3 9 to 23 7 6	25 15 0	28 5 0 to 28 0 0	154 10 0 to 154 12 6	155 5 0 to 155 7 6	35⅞	35¾	92 10	10

May, 1922, £27 4s. 9d. ; June, 1921, £27 2s. 2d. ; May, 1921, £27 6s. 7d.

Zinc Dust.—The market is unchanged, with prices as follow : Australian high-grade £50, American 92 to 94% £47 10s., and English 90 to 92% £45 per ton. Lower grades are obtainable at cheaper figures.

Antimony.—English regulus, ordinary brands, is nominally priced at £27 to £29 10s. per ton, supplies being somewhat short. Special brands are offered at £32 10s. to £35. As regards foreign regulus, the quotation for spot material is steady at £24 10s. ex warehouse.

Arsenic.—Business is stagnant, but the quotation for 99% Cornish white is firm at £42 10s. per ton, delivered London.

Bismuth.—The price is steady at about 9s. per lb.

Cadmium.—Inquiry is tending to fall away, but sellers still quote 5s. 9d. per lb.

Aluminium.—The market has undergone no change, domestic makers asking £100 per ton for home and £105 for export business. Continental material is quiet at about £82 10s. f.o.b.

Nickel.—The tendency has been rather easier, with makers quoting £160 per ton for home and export. Foreign metal is offering at less.

Cobalt Metal.—Steady at 12s. per lb.

Cobalt Oxides.—No change has occurred in quotations though demand is reported to have improved latterly. Grey oxide is priced at 10s. and black at 9s. per lb.

Platinum.—Manufactured material is quoted at £19 per oz., while raw is offered at £17.

Palladium.—Prices are steady, manufactured metal being quoted at £16 and raw at £12 per oz.

Quicksilver.—The present value is about £11 5s. to £11 10s. per bottle.

Selenium.—Unchanged at 7s. 9d. per lb.

Tellurium.—About 40s. per lb. is asked.

Manganese Ore.—Indian grades are about 1s. 2d. to 1s. 2½d. per unit c.i.f., which is also about the price for Caucasian.

Chrome Ore.—The quotation is steady, sellers still asking £4 5s. to £4 7s. 6d. per ton c.i.f.

Sulphate of Copper.—The tendency has been slightly easier, £27 per ton being now accepted for home and export orders.

Tungsten Ore.—65% WO_3 is available at 12s. 3d. per unit ex warehouse. China is holding for high figures, but 12s. has been bid for prompt shipment from Spain.

Molybdenite.—Business is dull. The price is steady at 32s. 6d. to 35s. per unit c.i.f. for 85% MoS_2.

Silver.—No serious fluctuations occurred during June. The price of spot bars opened at 36¼d. on June 1, but American and Chinese selling caused a drop to 35¼d. on the 6th. Subsequently India featured as a small buyer, while China bought and sold alternately. The quotation recovered to 35⅞d. on the 8th, fell to 35⅝d. on the 12th, rose again to 36⅛d. on the 14th, but relapsed to 35¾d. on the 16th. The 19th saw a firmer market at 36⅛d., and after slipping back to 35¾d. on the 21st, this figure was again quoted on the 27th. Spot bars closed the month at 36⅛d. on June 30.

Graphite.—Dealings are still restricted. Madagascar 80 to 90% is still quoted at £16 per ton c.i.f.

Iron and Steel.—The most important event recently in the iron and steel trades was the settlement of the engineering dispute. So far, it has perhaps brought no great results in the way of increased trade, but obviously the way has been paved for an extension in business such as was impossible so long as the trouble lasted. Generally speaking, steel business is not very good, and the recent reductions in railway rates, though a help, have not been important enough to make any great alteration in the cost prices of manufactured materials. Prices of steel, however, are on the down grade. As regards pig iron, the market is quiet, but the output of Cleveland is being pretty well absorbed, though there has been a slight expansion in Continental competition. Although some improvement is noticeable in the demand for hematite, there are pretty big stocks, and prices of this description are, on the whole, easy.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of Gold per oz.
	Oz.	Oz.	Oz.	s. d.
June, 1921	663,383	15,107	678,490	107 6
July	673,475	16,080	689,555	112 6
August	695,230	16,296	711,526	111 6
September	674,157	16,939	691,096	110 0
October	690,348	17,477	707,825	103 0
November	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921	7,924,534	190,052	8,114,586	—
January, 1922				95 6
February	594,788	44,940	639,728	92 6
March				94 0
April	493,402	17,936	511,338	92 0
May	612,702	17,083	629,786	92 0

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
March 31, 1921	174,364	14,906	1,364	190,634
April 30	172,826	14,908	1,316	189,050
May 31	170,595	14,510	1,302	186,407
June 30	168,152	14,704	1,317	184,173
July 31	166,999	14,688	1,246	182,933
August 31	169,008	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,410	13,465	1,217	191,092
December 31	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
May, 1921	1,955,357	35 3	26 2	9 1	889,520
June	1,966,249	35 10	25 10	10 0	979,769
July	2,010,236	37 2	25 7	11 7	1,163,565
August	2,050,722	37 3	25 4	11 11	1,226,282
September	1,997,086	36 8	25 2	11 6	1,151,127
October	2,041,581	34 4	24 9	9 7	981,597
November	2,007.617	34 6	24 9	9 9	978,931
December	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922, February, March	1,624,333	33 10	49 0	15 2*	1,233,033*
April	1,414,843	31 7	24 3	7 4	519,365

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May	46,266	48,744	53,920
June	45,054	49,466	—
July	46,208	51,564	—
August	48,740	53,200	—
September	4[illegible],471	52,436	—
October	47,343	53,424	—
November	46,782	53,098	—
December	46,190	55,968	—
Total	552,498	591,525	267,844

Transvaal Gold Outputs.

	April Treated Tons	April Yield Oz.	May Treated Tons	May Yield Oz.
Aurora West	7,160	£9,606†	9,400	£12,197*
Brakpan	32,000	14,201	52,500	25,525
City Deep	69,200	27,033	84,000	34,979
Cons. Langlaagte	25,800	£35,612†	33,600	£44,550*
Cons. Main Reef	35,000	13,039	45,600	15,855
Crown Mines	146,400	43,666	161,000	49,478
D'rb'nRoodepoortDeep	24,500	8,183	26,500	8,675
East Rand P.M.	85,000	22,997	102,000	26,012
Ferreira Deep	15,900	4,464	20,200	5,278
Geduld	43,200	15,781	45,800	16,333
Geldenhuis Deep	38,223	10,160	48,178	12,259
Glynn's Lydenburg	4,076	£7,071‡	4,036	£6,578§
Goch	16,400	£15,262†	16,550	£16,969*
Government G.M. Areas	105,500	£217,503†	139,000	£280,323*
Kleinfontein	27,400	6,846	42,100	10,313
Knight Central	19,100	4,773	24,000	5,286
Langlaagte Estate	35,000	£55,145†	40,700	£59,833*
Luipaard's Vlei	—	—	13,915	£11,539*
Meyer & Charlton	11,000	£31,205	12,000	£31,347*
Modderfontein, New	61,000	28,801	98,000	43,677
Modderfontein B	40,000	20,700	55,000	27,549
Modderfontein Deep	40,100	20,561	44,400	23,592
Modderfontein East	17,600	8,136	25,900	8,823
New Unified	8,700	£8,397†	10,600	£10,206*
Nourse	34,100	11,421	42,500	13,489
Primrose	14,500	£15,100†	16,506	£17,763*
Randfontein Central	88,700	£118,669†	103,500	£143,263*
Robinson	11,500	4,471	13,500	4,593
Robinson Deep	39,700	13,224	51,509	16,154
Roodepoort United	8,850	£8,506†	9,450	£9,010*
Rose Deep	38,200	9,882	43,400	10,744
Simmer & Jack	29,700	8,472	37,600	9,523
Springs	30,900	13,635	43,500	18,191
Sub-Nigel	10,200	5,597	8,800	5,714
Transvaal G.M. Estates	15,560	£25,253‡	15,790	£24,326§
Van Ryn	21,150	£26,159†	26,900	£34,991*
Van Ryn Deep	36,500	£74,913†	54,000	£117,418*
Village Deep	45,500	14,796	52,000	16,548
West Rand Consolidated	32,000	£40,681†	32,500	£41,157*
Witw'tersr'nd (Knights)	25,280	£29,544†	33,000	£45,310*
Witwatersrand Deep	27,680	8,340	30,000	9,798
Wolhuter	26,500	6,313	32,000	6,991

* £4 12s. per oz. ‡ £4 10s. per oz. † £4 12s. per oz.
§ £4 10s. per oz.

Rhodesian Gold Outputs.

	April. Tons	April. Oz.	May. Tons	May. Oz.
Cam & Motor	14,600	5,383	14,800	5,409
Falcon	15,840	3,243‖	16,200	3,100*
Gaika	4,049	£7,702	4,260	1,936
Globe & Phœnix	6,136	5,356	6,404	6,244
Jumbo	1,550	516	1,600	468
London & Rhodesian	4,119	£4,264	4,018	£5,072
Lonely Reef	5,650	4,982	5,500	4,130
Planet-Arcturus	5,600	2,095	5,900	2,049
Rezende	5,900	2,849	6,000	2,824
Rhodesia G.M. & I.	276	251	307	209
Shamva	50,550	£38,077§	61,050	£38,384‡
Transvaal & Rhodesian	—	—	1,700	£5,088†

* Also 293 tons copper. † At par. ‖ Also 298 tons copper.
§ Gold at £4 12s. 6d. per oz. ‡ Gold at £4 11s. per oz.

West African Gold Outputs.

	April Tons	April Oz.	May Tons	May Oz.
Abbontiakoon	8,090	£15,097*	7,530	£11,873*
Abosso	7,400	2,971	7,450	3,004
Ashanti Goldfields	7,072	5,396	6,101	5,095
Obbuassi	378	278	517	401
Prestea Block A	8,236	£14,826*	8,205	£14,784*
Taquah	2,800	1,611	2,508	1,414

* At par.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
September, 1921 ..	380	50,728	51,108	217,092
October	1,910	51,286	53,196	225,959
November	156	46,429	46,585	197,879
December	451	53,348	53,799	228,522
January, 1922.....	329	37,851	38,180	162,177
February	926	41,194	42,120	178,913
March............	180	42,842	43,022	182,745
April.............	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June	136	49,158	49,294	209,386

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	oz.	oz.	oz.	£
January .	38,181	4,411	448	11,855
February.	42,121	8,063	1,200	12,325
March ...	43,022	11,717	1,069	12,960
April	46,394	4,186	6,219	6,589
May	39,725	—	—	13,100
June.....	49,294	—	—	—
July	—	—	—	—
August...	—	—	—	—
September	—	—	—	—
October .	—	—	—	—
November	—	—	—	—
December	—	—	—	—
Total ..	258,737	28,379	8,936	56,829

Australasian Gold Outputs.

	April.		May	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	5,503	6,590‖	5,977	6,619‖
Blackwater (N.Z.)	2,862	5,647*	3,770	7,560*
Gold'n Horseshoe (W.A)	9,108	5,045‡	10,212	5,454‡
Grt Boulder Pro. (W.A.)	9,067	26,294‖	10,061	28,170‖
Hampton Celebr. (W.A.)	930	1,049	960	2,025
Ivanhoe (W.A.)	13,736	5,914‡	15,116	6,463‡
Lake View & Star (W.A.)	5,557	9,502‖	6,457	10,734‖
Menzies Con. (W.A.) ..	—	—	2,000	3,892
North Kalgurli (W.A.).	—	—	177	179‡
Oroya Links (W.A.) ...	1,430	7,794‖†	1,720	9,579‖†
South Kalgurli (W.A.) .	6,376	11,215‖	7,353	12,334‖
Waihi (N.Z.)..........	12,773	4,026‡ 18,862§	14,485	3,945‡ 36,585§
,, Grand Junc'n (N.Z.)	—	—	—	—

* Including premium ; † Including royalties ; ‡ Oz. gold ; § Oz. silver ; ‖ At par.

Miscellaneous Gold and Silver Outputs.

	April.		May	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	200*p*	—	151*p*
El Oro (Mexico)	33,710	175,485†	35,380	177,683†
Esperanza (Mexico)	—	2077*e*	—	4,247*e*
Frontino & Bolivia (C'lbia)	2,069	7,143	2,040	7,868
Keeley Silver (Canada) ..	—	50,500*s*	—	37,500*s*
Mexico El Oro (Mexico)..	13,070	184,530†	13,400	188,720†
Mining Corp. of Canada .	—	101,538*s*	8,189	118,853
Oriental Cons. (Korea) ...	—	89,500†	—	89,000†
Ouro Preto (Brazil)	6,700	2,341‖	7,800	2,783‖
Plym'th Cons. (Calif'rnia	9,000	9,835*	8,300	9,532*
St. John del Rey (Brazil).	—	39,000*	—	45,500*
Santa Gertrudis (Mexico)	33,069	26,859*e*	35,274	28,559*e*
Tomboy (Colorado)	16,000	69,000†	19,000	73,000†

* At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. *p* Oz. platinum and gold. *s* Oz. silver. *e* Profit in dollars.

Pato (Colombia) : 11 days to June 1, $61,796 from 74,741 cu. yd. ; 15 days to June 16, $69,753 from 73,883 cu. yd.

Nechi (Colombia) : 21 days to June 8, $23,005 from 208,371 cu. yd.

Indian Gold Outputs.

	April.		May	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,150	2,533	3,700	2,773
Champion Reef	11,985	4,913	12,395	4,914
Mysore...............	18,265	10,502	18,342	10,496
North Anantapur	550	602	600	716
Nundydroog	9,352	5,026	9,498	5,043
Ooregum	12,900	8,493	13,000	8,585

Production of Gold in India.

	Reported by English mining companies.				Total.
	1918	1919	1920	1921	1922
	Oz.	Oz.	Oz.	Oz.	Oz.
January	41,420	38,184	39,073	34,028	35,493
February ...	40,787	36,384	38,872	32,529	34,690
March	41,719	38,317	38,760	32,576	35,607
April	41,504	38,248	37,307	32,363	—
May........	40,889	38,608	38,191	32,656	—
June	41,264	38,359	37,864	32,207	—
July	40,229	38,549	37,129	32,278	—
August	40,496	37,850	37,375	32,498	—
September ..	40,088	36,813	35,497	32,642	—
October	39,472	37,138	35,023	32,186	—
November ..	36,984	39,628	34,522	32,293	—
December ..	40,149	42,643	34,919	32,578	—
Total ..	485,236	461,171	444,532	390,549	105,790

Base Metal Outputs.

		April.	May.
Broken Hill British....	Tons lead carb. ore.	510	410
	Tons lead conc.	3,443	2,641
	Tons zinc conc......	2,970	2,355
Broken Hill Prop......	Tons lead conc. ...	1,562	1,753
	Tons zinc conc.	3,251	6,027
Broken Hill South	Tons lead conc.	3,966	5,103
Burma Corporation....	Tons refined lead ..	3,029	3,140
	Oz. refined silver ..	320,767	296,392
Electrolytic Zinc	Tons zinc...........	1,686	1,825
Fremantle Trading ...	Tons lead...........	—	209
Mount Lyell	Tons copper	461	392
	Oz. silver	10,442	7,586
	Oz. gold	168	123
Mount Morgan	Tons copper	441	—
	Oz. gold	5,155	—
North Broken Hill.....	Tons lead conc......	1,760	2,070
	Tons zinc conc......	1,720	1,840
Poderosa.............	Tons copper ore	706	600
Rhodesia Broken Hill	Tons lead	1,844	1,904
Sulphide Corporation ..	Tons lead conc. ...	2,006	2,343
	Tons zinc conc	3,150	4,011
Union Minière	Tons copper	3,290	3,798
Transvaal Silver	Tons silver-lead bullion	362	401
Zinc Corporation	Tons zinc conc......	7,490	9,345
	Tons lead conc. ...	934	1,380

Imports of Ores, Metals, etc., into United Kingdom.

		April.	May.
Iron Ore	Tons	255,687	410,821
Manganese Ore	Tons	8,712	31,518
Iron and Steel	Tons	59,863	60,939
Copper and Iron Pyrites	Tons	30,492	64,806
Copper Ore, Matte, and Prec.	Tons	825	456
Copper Metal	Tons	3,906	2,483
Tin Concentrate	Tons	2,146	2,820
Tin Metal......................	Tons	2,473	2,222
Lead, Pig and Sheet	Tons	14,180	15,860
Zinc (Spelter)	Tons	3,966	7,698
Zinc Sheets, etc.................	Tons	1,360	777
Quicksilver	Lb.	91,568	—
Zinc Oxide......................	Tons	396	358
White Lead	Cwt.	10,541	13,112
Barytes, ground	Cwt.	64,575	54,665
Asbestos	Tons	2,370	1,313
Phosphate of Lime..............	Tons	16,444	45,473
Mica..........................	Tons	65	87
Sulphur	Tons	1,121	5,628
Nitrate of Soda.................	Cwt.	8,120	62,140
Petroleum : Crude	Gallons	9,919,740	32,485,858
Lamp Oil	Gallons	17,216,487	17,736,493
Motor Spirit	Gallons	26,702,668	36,129,440
Lubricating Oil	Gallons	8,238,537	2,708,551
Gas Oil	Gallons	4,573,785	8,501,031
Fuel Oil	Gallons	56,653,524	32,411,674
Asphalt and Bitumen............	Tons	8,644	6,978
Paraffin Wax	Cwt.	99,456	79,041
Turpentine	Cwt.	5,389	24,638

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Mar.	April.	May
Nigeria:	Tons	Tons	Tons
Bisichi	33	25	22½
Ex-Lands	30	—	—
Filani	2½	2	2
Gold Coast Consolidated	—	—	—
Gurum River	9	9	9
Jos	11	8	10¼
Kaduna	22¼	15¼	—
Kaduna Prospectors	20½	19¼	—
Keffi Consolidated	20	20	—
Lower Bisichi	3½	3½	4
Mongu	37½	33½	30
Naraguta	55	40	37
Naraguta Extended	5	7	8
Nigerian Consolidated	11	8	7
N.N. Bauchi	40	36½	45
Rayfield	40	40	40
Ropp	126	143	189
Rukuba	4	4	[illegible]
South Bukeru	20	20	20
Tin Fields	8	—	—
Yarde Kerri	10	9½	8
Federated Malay States:			
Chenderiang	72*	—	—
Gopeng	[illegible]	72	72
Idris Hydraulic	19½	19¼	18¼
Ipoh	[illegible]	[illegible]	24½
Kamunting	[illegible]*	—	—
Kinta	42¼	40	37
Lahat	21¾	26¾	37¼
Malayan Tin	78¾	77½	77¼
Pahang	233	234	219½
Rambutan	18	19½	20
Sungei Besi	39	39	39
Tekka	42	42	36
Tekka-Taiping	30	30	23
Tronoh	76½	74	89
Other Countries:			
Aramayo Mines (Bolivia)	235	259	249
Berenguela (Bolivia)	32	58	34
Briseis (Tasmania)	—	—	—
Deebook Ronpibon (Siam)	29	21½	21
Leeuwpoort (Transvaal)	71*	—	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	77	85½	66
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	103¾	93¼	120
Tongkah Harbour (Siam)	75	88	98
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note.—These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	[illegible]	678	613	547	438	473
February	[illegible]	668	623	477	270	412
March	655	707	606	505	445	[illegible]
April	555	[illegible]	546	467	394	[illegible]
May	509	[illegible]	483	383	337	—
June	[illegible]	492	484	435	423	—
July	[illegible]	[illegible]	481	484	494	—
August	[illegible]	571	616	447	477	—
September	538	[illegible]	561	528	595	—
October	578	[illegible]	625	628	546	—
November	621	472	536	544	564	—
December	655	518	511	577	555	—
Total	6,927	6,771	[illegible]	6,022	5,618	[illegible]

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,030	3,765	4,265	3,298	3,143
February	3,197	2,734	3,014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	—
July	3,373	3,756	2,824	2,734	—
August	3,259	2,956	2,786	3,051	—
September	3,157	3,161	2,734	2,338	—
October	2,879	3,221	2,837	3,161	—
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	14,554

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	Apr. 30	May 31	June 30
Straits and Australian Spot	1,351	999	1,151
Ditto, Landing and in Transit	175	560	670
Other Standard, Spot and Landing	5,627	5,804	4,690
Straits, Afloat	875	1,100	2,555
Australian, Afloat	75	60	45
Banca, in Holland	2,884	2,857	2,776
Ditto, Afloat	651	502	1,214
Billiton, Spot	83	72	60
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	740	630	572
Total Afloat for United States	6,052	7,730	6,452
Stock in America	2,721	1,921	2,371
Total	21,244	22,235	22,558

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	Apr.	May	June
Shipments from:			
Straits to U.K.	825	1,050	2,595
Straits to America	3,800	4,860	3,465
Straits to Continent	725	510	445
Straits to other places	175	175	100
Australia to U.K.	25	—	—
U.K. to America	414	125	355
Imports of Bolivian Tin into Europe	411	1,233	2,462
Supply:			
Straits	5,350	6,420	6,505
Australian	130	—	—
Billiton	—	—	—
Banca	1,560	1,835	1,229
Standard	890	616	545
Tota	7,930	8,871	8,279
Consumption:			
U.K. Deliveries	2,009	2,047	1,929
Dutch ,,	75	274	299
American ,,	4,995	4,740	5,130
Straits, Banca & Billiton, Continental Ports, etc.	647	819	598
Total	7,726	7,880	7,956

Imports and Exports of Gold and Silver

During May, 1922.

		Imports.	Exports.
Gold:	Unrefined Bullion .... £	1,014,274	—
	Refined Bars .... ,,	2,131,008	2,124,774
	Coin .... ,,	2,012	698,947
Silver:	Unrefined Bullion ... oz.	741,405	—
	Refined Bars .... ,,	2,746,717	10,140,673
	Coin .... £	608,854	100,090

Outputs Reported by Oil-producing Companies.

In Tons.

	Mar.	Apr.	May
Anglo-Egyptian	15,435	12,290	15,564
Anglo-Texas	2,187	1,892	1,922
Anglo-United	1,046	954	—
Apex Trinidad	6,600	4,450	7,600
Astra Romana	35,479	32,698	35,400
British Burmah	10,751	10,285	—
Caltex	7,492	8,063	11,613
Dacia Romana	211	205	798
Indo-Burma	1,224	—	—
Kern River	16,516	16,712	15,814
Lobitos	9,123	8,691	8,903
Phœnix	3,927	2,289	3,216
Romana Americana	21,882	20,348	26,300
Roumanian Consolidated	1,763	2,120	2,307
Santa Maria	1,814	2,021	1,629
Steaua Romana	18,300	17,570	18,697
Trinidad Leaseholds	9,050	8,500	9,550
United of Trinidad	3,469	4,170	3,293

Quotations of Oil Companies' Shares.

Denomination of Shares £1 unless otherwise noted.

	June 6, 1922			July 5, 1922		
	£	s.	d.	£	s.	d.
Anglo-American	5	5	0	4	11	3
Anglo-Egyptian B	1	15	0	1	15	0
Anglo-Persian 1st Pref.	1	5	0	1	5	6
Apex Trinidad	2	2	6	1	17	6
British Borneo (10s.)		12	6		12	6
British Burmah (8s.)		13	9		12	0
Burmah Oil	5	10	0	5	5	0
Caltex ($1)		2	6		2	0
Dacia Romano	1	3	9	1	0	0
Kern River, Cal. (10s.)	1	1	6	1	1	0
Lobitos, Peru	5	11	3	4	18	9
Mexican Eagle, Ord. ($5)	3	8	9	3	5	0
,, ,, Pref. ($5)	3	5	0	3	1	3
North Caucasian (10s.)		12	6		11	3
Phœnix, Roumania	1	8	0	1	8	0
Roumanian Consolidated		17	0		18	9
Royal Dutch (100 gulden)	42	10	0	39	5	0
Scottish American		2	6		2	3
Shell Transport, Ord.	4	17	6	4	13	9
,, ,, Pref. (£10)	9	12	6	9	12	6
Trinidad Central	2	2	6	2	0	0
Trinidad Leaseholds	1	3	0	1	2	6
United British of Trinidad		12	6		8	9
Ural Caspian		15	0		13	0
Uroz Oilfields (10s.)		12	0		11	6

Petroleum Products Prices. July 7.

Refined Petroleum: Water white, 1s. 2d. per gallon; standard white, 1s. 1d. per gallon; in barrels 3d. per gallon extra.

Motor Spirit: In bulk: Aviation spirit, 2s. 6d. per gallon; No. 1, 2s. 2d. per gallon; No. 2, 2s. per gallon.

Fuel Oil: Furnace fuel oil, £3 12s. 6d.; Diesel oil, £4 2s. 6d. per ton.

American Oils: Best Pennsylvania crude at wells, $3·50 per barrel. Refined standard white for export in bulk, 6 cents per U.S. gallon; in barrels 12 cents. Refined water white for export in bulk, 7 cents per U.S. gallon; in barrels 13 cents.

Dividends Declared by Mining Companies

During month ended July 10.

Company	Par Value of Shares	Amount of Dividend
Anglo-American Oil	Ord. £1	2s. tax paid.
Apex Mines	10s.	5% less tax.
Bantjes Consolidated	£1	4s.†
Burmah Oil	Ord. £1	4s. tax paid.
Central Mining and Investment	£8	6s. tax paid.
Frontino and Bolivia	Ord. £1	2½% less tax.
Gopeng Consolidated	£1	9d. less tax.
Ivanhoe Gold	£5	1s. 6d less tax.
Johannesburg Consolidated	£1	7½% tax paid.
Kinta Tin	£1	5% less tax.
Mexico of El Oro	£1	4s. tax paid.
Minerals Separation North American	-	$5·00*
Nechi Mines	Pref. 10s	7½d. less tax.
Rand Mines	5s.	1s. less tax.
Shamva Mines	£1	7½% less tax.
Tekka	£1	4½d. less tax.
Tronoh Mines	£1	1s. less tax.

* Payable as to $3·75 out of capital assets and $1·25 out of accumulated surplus. † First distribution on liquidation.

PRICES OF CHEMICALS. July 7.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	0
,, 80%	,,	1	8	0
,, Glacial	per ton	65	0	0
Alum	,,	14	0	0
Alumina, Sulphate	,,	11	10	0
Ammonia, Anhydrous	per lb.		2	2
,, 0·880 solution	per ton	25	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	35	0	0
,, ,, pure	per cwt.	3	5	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	65	0	0
,, Sulphate	,,	17	0	0
Antimony, Tartar Emetic	per lb.		1	7
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	39	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			7
,, Chloride	per ton	22	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		2	0
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	14	0	0
,, Liquor, 7%	,,	5	0	0
Borax	,,	29	0	0
Boric Acid Crystals	,,	60	0	0
Calcium Chloride	,,	7	0	0
Carbolic Acid, crude 60%	per gal.		1	10
,, ,, crystallized, 40	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		2	6
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100%	per lb.			10½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	8	10	0
,, Sulphate	,,	3	0	0
Lead, Acetate, white	,,	40	0	0
,, Nitrate	,,	46	0	0
,, Oxide, Litharge	,,	36	0	0
,, White	,,	41	0	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey 80%	,,	13	10	0
Magnesite, Calcined	,,	12	0	0
Magnesium, Chloride	,,	9	0	0
,, Sulphate	,,	9	0	0
Methylated Spirit 64° Industrial	per gal.		3	0
Nitric Acid, 80° Tw.	per ton	27	0	0
Oxalic Acid	per lb.			8
Phosphoric Acid	per ton	40	0	0
Potassium Bichromate	per lb.			6½
,, Carbonate	per ton	29	0	0
,, Chlorate	per lb.			5
,, Chloride 80%	per ton	12	0	0
,, Hydrate (Caustic) 90%	,,	32	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			9
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	6
,, Sulphate, 90%	per ton	15	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate 45%	,,	38	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			6
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	6	0	0
,, Chlorate	per lb.			3½
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 96%	,,	15	0	0
,, Phosphate	,,	18	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	15	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salt)	,,	4	10	0
,, Sulphide	,,	22	0	0
,, Sulphite	,,	12	10	0
Sulphur, Roll	,,	10	10	0
,, Flowers	,,	10	10	0
Sulphuric Acid, Fuming, 65	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 35%	,,	4	17	6
Tartaric Acid	per lb.		1	4
Turpentine	per cwt.	5	11	0
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	0
Zinc Chloride	per ton	20	0	0
Zinc Oxide	,,	36	0	0
Zinc Sulphate	,,	13	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	July 6, 1921 £	s.	d.	July 5, 1922 £	s.	d.
RAND:						
Brakpan	2	12	6	2	11	3
Central Mining (£8)	6	0	0	8	0	0
City & Suburban (£4)		3	0		2	6
City Deep	2	6	3	2	11	3
Consolidated Gold Fields		18	9		16	3
Consolidated Langlaagte		12	6		15	6
Consolidated Main Reef		9	6		11	6
Consolidated Mines Selection (10s.)		13	0		14	6
Crown Mines (10s.)	1	15	0	2	3	9
Daggafontein		3	6		3	3
Durban Roodepoort Deep		3	9		6	9
East Rand Proprietary		4	3		8	0
Ferreira Deep		7	6		8	0
Geduld	2	8	9	3	7	6
Geldenhuis Deep		5	3		7	0
Government Gold Mining Areas	4	1	3	5	1	3
Johannesburg Consolidated	1	3	6	1	7	0
Kleinfontein		5	3		7	0
Knight Central		4	0		4	6
Langlaagte Estate		13	6		16	6
Luipaards Vlei		1	6		2	6
Meyer & Charlton	4	7	6	3	18	9
Modderfontein, New (10s.)	3	7	6	4	0	0
Modderfontein B (5s.)	1	7	6	1	15	0
Modderfontein Deep (5s.)	2	5	0	2	7	6
Modderfontein East		10	0		8	3
New State Areas	1	2	6	1	13	9
Nourse		7	0		16	6
Rand Mines (5s.)	2	1	3	2	10	0
Rand Selection Corporation	2	12	6	2	17	6
Randfontein Central		9	0		12	0
Robinson (£5)		9	6		8	3
Robinson Deep A (1s.)		7	6		14	6
Rose Deep		12	3		14	6
Simmer & Jack		2	9		4	0
Springs	1	18	9	2	7	6
Sub-Nigel		12	6		13	0
Union Corporation (12s. 6d.)		15	0		19	3
Van Ryn		12	3		13	5
Van Ryn Deep	3	12	6	3	13	9
Village Deep		7	6		11	9
West Springs		10	0		12	0
Witwatersrand (Knight's)		13	9		15	0
Witwatersrand Deep		6	3		10	6
Wolhuter		3	6		3	6
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		6	6		16	3
Transvaal Gold Mining Estates		7	6		11	0
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	10	5	0	11	13	9
Jagersfontein	2	5	0	2	15	0
Premier Deferred (2s. 6d.)	4	0	0	5	0	0
RHODESIA:						
Cam & Motor		9	0		14	0
Chartered British South Africa		11	9		13	0
Falcon		4	6		4	6
Gaika		9	9		11	6
Globe & Phœnix (5s.)		15	6		13	0
Lonely Reef	2	0	0	2	7	6
Rezende	3	10	0	2	15	0
Shamva	1	10	0	1	10	9
WEST AFRICA:						
Abbontiakoon (10s.)		2	3		2	0
Abosso		8	3		7	9
Ashanti (4s.)		14	3		13	3
Prestea Block A		1	6		1	3
Taquah		8	6		7	6
WEST AUSTRALIA:						
Associated Gold Mines		2	6		6	9
Associated Northern Blocks		2	6		2	3
Bullfinch (5s.)		1	0		1	0
Golden Horse-Shoe (£5)		10	0		10	0
Great Boulder Proprietary (2s.)		5	0		1	9
Great Fingall (10s.)		1	6		1	0
Hampton Celebration		3	6		3	6
Hampton Properties		4	9		6	0
Ivanhoe (£5)		16	3		16	3
Lake View Investment (10s.)		9	6		9	6
Lake View and Star (4s.)		1	6		2	3
Oroya Links (5s.)		1	3		1	3
Sons of Gwalia		4	6		3	0
South Kalgurli (10s.)		7	6		7	6

GOLD, SILVER, *cont.*	July 6, 1921 £	s.	d.	July 5, 1922 £	s.	d.
NEW ZEALAND:						
Blackwater		2	6		5	0
Waihi	1	8	9	1	10	0
Waihi Grand Junction		10	0		10	0
AMERICA:						
Buena Tierra, Mexico		2	6		1	9
Camp Bird, Colorado		4	0		5	3
El Oro, Mexico		9	9		9	3
Esperanza, Mexico	1	0	0		13	0
Frontino & Bolivia, Colombia		7	6		8	9
Kirkland Lake, Ontario		15	0		14	0
Le Roi No. 2 (£5), British Columbia		2	6		2	6
Mexico Mines of El Oro, Mexico	4	5	0	3	7	6
Nechi (Pref. 10s.), Colombia		7	6		5	6
Oroville Dredging, Colombia	1	5	0	1	1	3
Plymouth Consolidated, California		12	6		8	9
St. John del Rey, Brazil		15	3		19	9
Santa Gertrudis, Mexico		5	6		9	9
Tomboy, Colorado		5	0		9	6
RUSSIA:						
Lena Goldfields		8	9		7	6
Orsk Priority		5	0		5	0
INDIA:						
Balaghat (10s.)		8	6		7	9
Champion Reef (2s. 6d.)		1	6		4	3
Mysore (10s.)		12	6		11	6
North Anantapur		2	6		2	6
Nundydroog (10s.)		6	0		7	6
Ooregum (10s.)		12	6		13	9

COPPER:

	July 6, 1921 £	s.	d.	July 5, 1922 £	s.	d.
Arizona Copper (5s.), Arizona	1	3	9		17	6
Cape Copper (£2), Cape and India		15	0		7	6
Esperanza, Spain		6	3		5	0
Hampden Cloncurry, Queensland		5	0		7	6
Mason & Barry, Portugal	1	15	0	2	7	6
Messina (5s.), Transvaal		4	0		3	0
Mount Elliott (£5), Queensland		7	6		8	9
Mount Lyell, Tasmania		13	9		16	6
Mount Morgan, Queensland		12	6		13	0
Namaqua (£2), Cape Province		15	0	1	7	6
Rio Tinto (£5), Spain	31	0	0	27	5	0
Russo-Asiatic Consd., Russia		11	0		7	9
Sissert, Russia		7	6		4	6
Spassky, Russia		11	3		8	9
Tanganyika, Congo and Rhodesia	1	0	0		15	6

LEAD-ZINC:

	July 6, 1921 £	s.	d.	July 5, 1922 £	s.	d.
BROKEN HILL:						
Amalgamated Zinc		17	6		13	9
British Broken Hill	1	1	3	1	2	6
Broken Hill Proprietary	2	2	6	1	5	0
Broken Hill Block 10 (£10)		12	6		6	3
Broken Hill North	1	10	0	1	12	6
Broken Hill South	1	8	9	1	12	6
Sulphide Corporation (15s.)		12	6		10	6
Zinc Corporation (10s.)		8	9		10	0
ASIA:						
Burma Corporation (10 rupees)		7	6		6	6
Russian Mining		7	0		2	6
RHODESIA:						
Rhodesia Broken Hill (5s.)		7	0		6	6

TIN:

	July 6, 1921 £	s.	d.	July 5, 1922 £	s.	d.
Aramayo Mines, Bolivia	2	5	0	2	5	0
Bisichi (10s.), Nigeria		6	6		5	3
Briseis, Tasmania		2	6		3	3
Chenderiang, Malay		13	0		10	0
Dolcoath, Cornwall			9			9
East Pool (5s.), Cornwall		3	3		2	9
Ex-Lands Nigeria (2s.), Nigeria		1	6		1	6
Geevor (10s.), Cornwall		3	9		3	0
Gopeng, Malay	1	12	6	1	15	0
Ipoh Dredging, Malay		11	3		7	6
Kamunting, Malay	1	5	0		16	3
Kinta, Malay	1	10	0	1	16	3
Lahat, Malay	1	5	0		6	3
Malayan Tin Dredging, Malay	1	7	6	1	3	9
Mongu (10s.), Nigeria		12	6		10	0
Naraguta, Nigeria		16	3		15	0
N. N. Bauchi, Nigeria (10s.)		2	3		2	0
Pahang Consolidated (5s.), Malay		6	3		5	0
Rayfield, Nigeria		4	0		2	3
Renong Dredging, Siam	1	7	6		18	9
Ropp (4s.), Nigeria		6	6		6	0
Siamese Tin, Siam	1	12	6	1	15	0
South Crofty (5s.), Cornwall		4	6		4	3
Tehidy Minerals, Cornwall		7	6		7	6
Tekka, Malay		17	6		15	6
Tekka-Taiping, Malay	1	1	3		18	9
Tronoh, Malay	1	5	0	1	8	9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

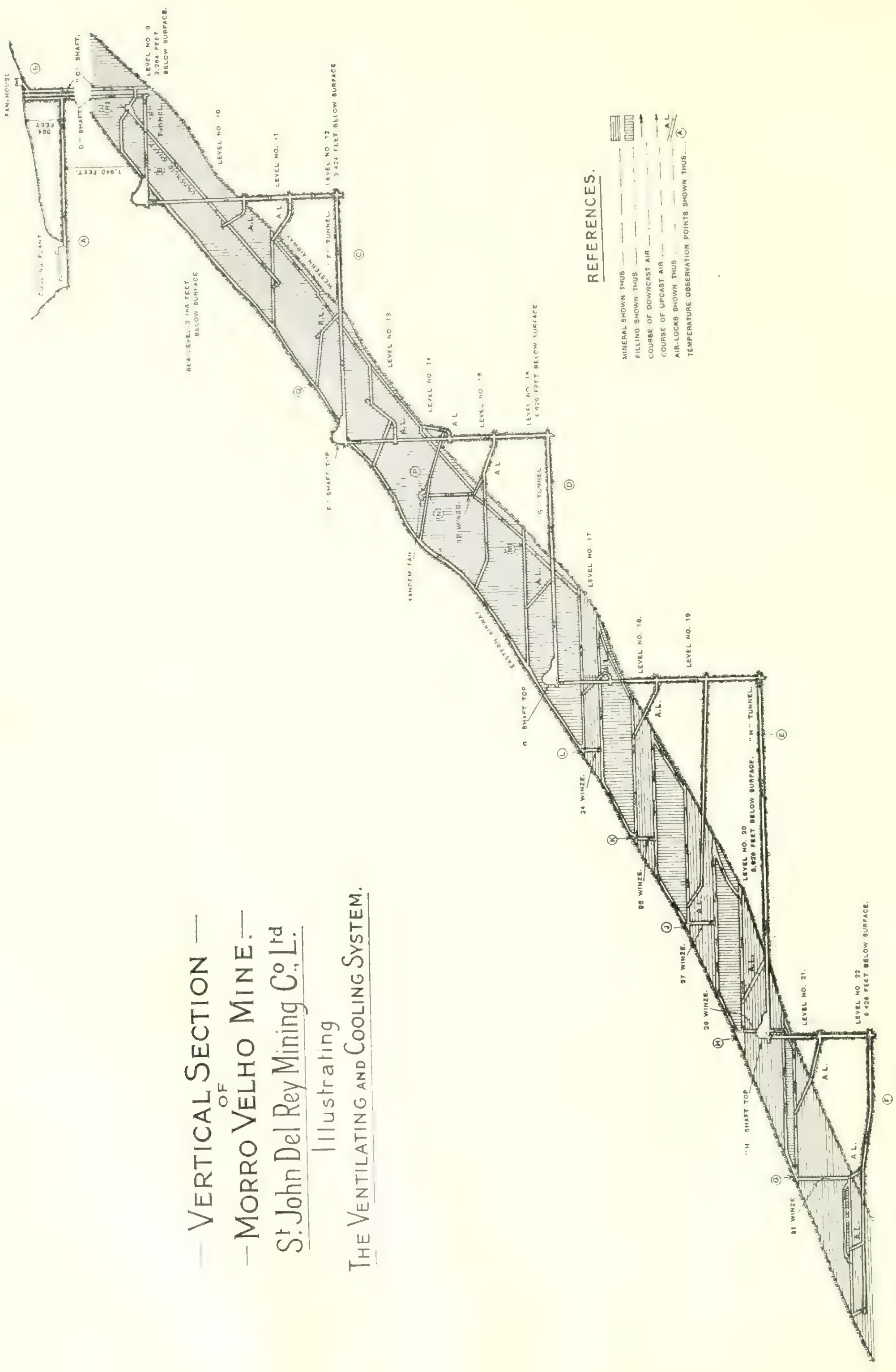
AIR-COOLING AT ST. JOHN DEL REY

A paper was read by Eric Davies at the meeting of the Institution of Mining Engineers, held at Sheffield last month, on the air-cooling plant at the Morro Velho mine of the St. John del Rey Company in Brazil. Mr. Davies read a paper on this subject before the same society in 1919, and quotations from that paper were given in our issue for October of that year. We quote at some length from the paper now published, though, owing to limits of space, it is not possible to give the paper in full or reproduce all the illustrations.

The author commences by giving an outline of the conditions at the mine as regards temperature and moisture content, and the reasons for installing the plant now described. During the hot and rainy season, when the absolute moisture-content of the surface air entering the downcast shaft was almost continuously above its average value, the absolute moisture-content of the air passing any point underground was also continuously above its average value for that point; hence, since the dry-bulb temperature and barometric pressure at any one point underground remained approximately constant, the wet-bulb temperature at that point was also continuously above its average value. During the dry and cooler winter season, when the absolute moisture-content of the surface air entering the downcast shaft was almost continuously below its average value, the wet-bulb temperature at any one point underground was similarly continuously below its average value for that point. As regards the stopes, the maximum wet-bulb temperatures attained were so high that while they were liable to occur it would not have been possible to work the mine profitably at depths much greater than those which had already been reached; however, during the winter season conditions on the stopes were considerably improved on account of the lower wet-bulb temperatures prevailing there. It was consequently decided to instal on the surface a plant through which should pass the whole of the air entering the mine, except that entering in a compressed condition by the air-compressors and air-mains to operate underground hoists, rock-drills, etc., and that this plant should continuously reduce the air passing through it to a condition approximately equal to that obtaining on a cold winter's morning. The guaranteed capacity of this plant was that it should have a heat-extraction rate of not less than 100,600 B.Th.U. per minute; this corresponds to the reduction to 43·2° F from an initial wet-bulb temperature of 72° F and any degree of saturation of 5,040 pounds of dry air per minute.

The author proceeds to describe the plant erected. This plant is similar in principle to an ordinary cold-storage plant with a brine-circulation system, but as the temperatures do not fall below 32° F, ordinary water is used instead of brine, and the place of the cold-storage chamber is taken by two large air-coolers. As the wet-bulb temperature of the air entering the plant is liable to have any value between 75° and 32° F, according to the season and time of day, and as it is obviously desirable to supply the mine with air at a fairly steady temperature, the plant is divided into six stages, in which the temperature is reduced respectively from 72° to 67·6° F, 67·6° to 62·6°, 62·6° to 57·6°, 57·6° to 52·6°, 52·6° to 47·8°, and 47·8° to 43·2°. Hence, when the wet-bulb temperature of the air entering the coolers is between 67·6° and 62·6° F, the first stage can be shut down and the plant run on the remaining five stages; when it is between 62·6° and 57·6°, the first and second stages can be shut down, and so on, until, when the initial wet-bulb temperature is below 43·2°, as happens on cold winter nights and mornings, the whole plant can be temporarily put out of commission.

A section of the workings is reproduced overleaf. The direction of the main ventilating current is marked by arrows, while points at which observations of dry and wet-bulb temperatures, etc., have been regularly made are indicated by the letters A, B, C, etc., enclosed within circles. The ore-body is attacked at each level (the levels being 300 ft. apart vertically) and the excavated mineral is replaced by earth-filling brought down from the surface; thus the stopes, where this process is going on, gradually work their way upwards until the next level higher up is reached. Five stopes, lying between Level No. 22 and Level No. 17, are now being operated, and hence the working zone where the bulk of the mine force is at work lies between points F and L. As regards ventilation, there is now installed, in the upcast, at Level No. 14 and at the top of winze 17, a fan of equal size and speed to that of the fan operating in the surface fan-house at the top of the C or upcast-shaft, and the two fans now work in tandem or series. The resulting increase in underground volume amounted to about 40%, an increase mainly due to the new fan. Fig. 1 indicates the gradual fall in temperatures effected by the new plant. The lowest curve shows the average monthly dry-bulb temperatures of the air on entrance to the mine, while the upper curves show corresponding underground rock- and dry-bulb air-temperatures measured in the downcast. The base-line of this figure represents a period of thirty months, during the first thirteen of which the cooling plant was not in regular operation. When in December, 1920, the plant was put into regular 24-hour service, it was purposely run for some months with an average exit-temperature slightly over 50° F; however, during the cold months (May to August, 1921) the initial temperature of the air was, during the night, frequently well below this figure, and thus the average cooling-plant exit-temperatures for these months also fell below it, as shown. At the end of November, 1921, after practically a year's running, the exit-temperature was lowered to approximately the figure for which the plant was designed (43° F), where it has since remained.



— Vertical Section —
of
— Morro Velho Mine. —
St. John Del Rey Mining Co. Ltd.
Illustrating
The Ventilating and Cooling System.
REFERENCES.
MINERAL SHOWN THUS
FILLING SHOWN THUS
COURSE OF DOWNCAST AIR
COURSE OF UPCAST AIR
AIR-LOCKS SHOWN THUS
TEMPERATURE OBSERVATION POINTS SHOWN THUS
FAN-HOUSE
"C" SHAFT.
"D" SHAFT
LEVEL NO. 9 2,264 FEET BELOW SURFACE.
LEVEL NO. 10
LEVEL NO. 11
LEVEL NO. 12 3,424 FEET BELOW SURFACE
1,940 FEET.
"F" TUNNEL
WESTERN AIRWAY
LEVEL NO. 13
LEVEL NO. 14
LEVEL NO. 15
LEVEL NO. 16 4,626 FEET BELOW SURFACE
"F" SHAFT TOP
"G" TUNNEL
TANDEM FAN
EASTERN AIRWAY
LEVEL NO. 17
LEVEL NO. 18.
LEVEL NO. 19
"G" SHAFT TOP
24 WINZE.
26 WINZE.
27 WINZE.
29 WINZE.
31 WINZE
LEVEL NO. 20 5,626 FEET BELOW SURFACE.
"H" TUNNEL.
LEVEL NO. 21.
"H" SHAFT TOP
LEVEL NO. 22 6,426 FEET BELOW SURFACE.
A.L.

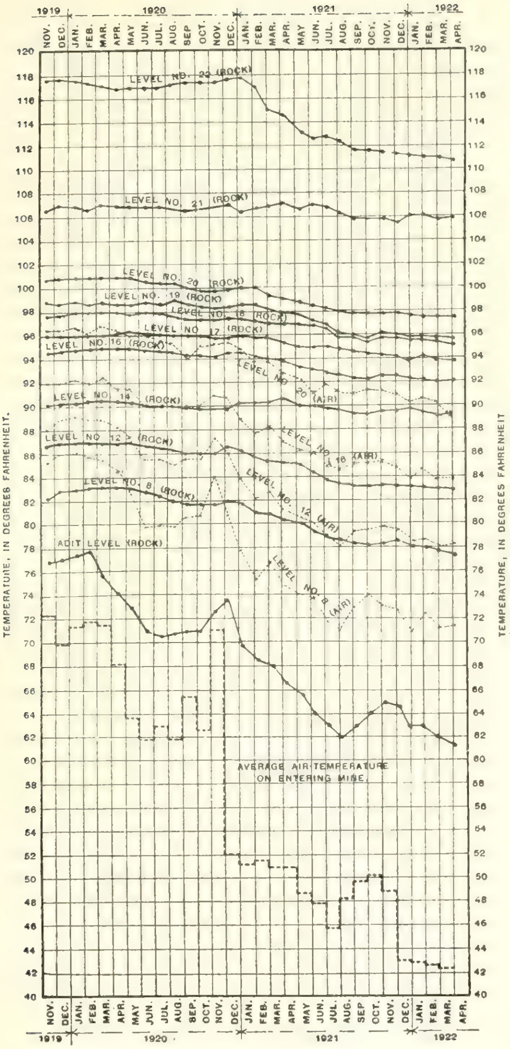


FIG. 1.—RATE OF ALTERATION IN DOWNCAST ROCK AND AIR TEMPERATURES.

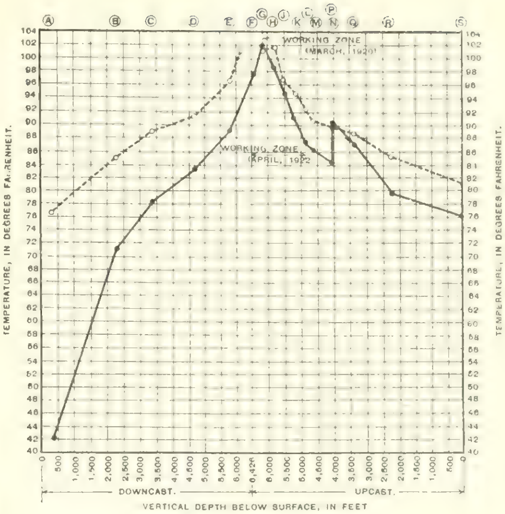


FIG. 2.—COMPARISON OF TYPICAL FORMER UNDERGROUND DRY-BULB TEMPERATURES WITH THOSE PREVAILING IN APRIL, 1922

The author proceeds to give the total alterations which have so far been caused. The underground dry- and wet-bulb temperatures and moisture-contents liable to be reached before the cooling plant was started up may be compared with those prevailing at the present time by an inspection of Figs. 2, 3, and 4, the base-lines of which represent vertical distances down and up covered by the main ventilating current. In each of the diagrams the dotted curve relates to observations made on March 3, 1920, while the full-line curve illustrates a test made on April 5, 1922. In each case there is a gap in the centre of the dotted curve; the reason for this is that at the time to which these curves refer (March, 1920) the main ventilating current only reached Level No. 21 (since as previously stated, the connexion at Level No. 22 between winze 31 bottom and the drive from the *H* shaft was not completed until January, 1921), and hence the path traversed by the main ventilating current was 600 vertical feet (300 down and 300 up) shorter than is the case at present.

From Fig. 2 it will be seen that a marked dry-bulb temperature-drop has taken place throughout the whole of the downcast way, and that the air now reaches Level No. 22 at a temperature 3·7° F lower than that at which it used to arrive at Level No. 21. In the stopes (marked "working zone" in the diagram) the drop is not so great, owing to the fact that fresh and comparatively uncooled rock is always being brought into contact with the air; even so, however, the average reduction for points G, H, J, K, and L is 2·5° F. Higher up in the upcast the drop becomes more considerable, owing probably to heat-leakage from upcast to downcast through the intervening rock. The sudden rise in temperature (5·9° F) which the upcast air now experiences at Level No. 14 is due to the combined effects of compression and friction-loss in its passage through the tandem fan, and shows how important it is that such fans, when used in a hot mine, should not be placed in a position where the air discharged from them passes immediately over any place where miners are at work. Both the tandem and the surface fans are each 84 in. in diameter, and are single-inlet Sirocco fans direct coupled to 415-revolutions-per-minute 200 brake-horse-power motors; owing to the differing air-densities, the water-gauges set up are different, being about 8·15 in. for the surface fan and 8·85 in. for the underground fan.

In Fig. 3 the dotted curve shows that the maximum wet-bulb temperature observed in the working zone during the test in March, 1920, was 89·7° F. It will be seen from Figs. 2, 3, and 4 that the initial condition of the air at the surface entering the mine on that occasion was: dry-bulb temperature, 76·4° F; wet-bulb, 70·6° F; absolute moisture-content, 114 grains per pound of dry air. Now the hourly records of surface dry- and wet-bulb temperatures show that considerably higher values than this of the surface absolute

moisture-current occur at times, values of 120 to 130 grains per pound of dry air being comparatively common during the summer months. It is unfortunate that no underground observations were made under such conditions; there can be no doubt, however, that the wet-bulb temperatures in the stopes must at times have reached values of 90° F and over during the last summer (1919–1920) before the cooling plant was started up.

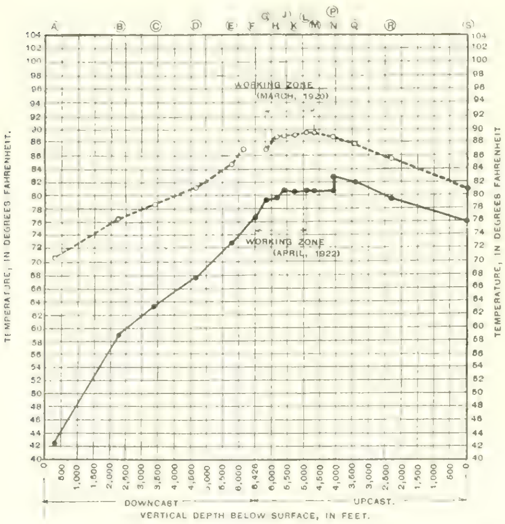


Fig. 3.—Comparison of Typical Former Underground Wet-Bulb Temperatures with those prevailing in April, 1922.

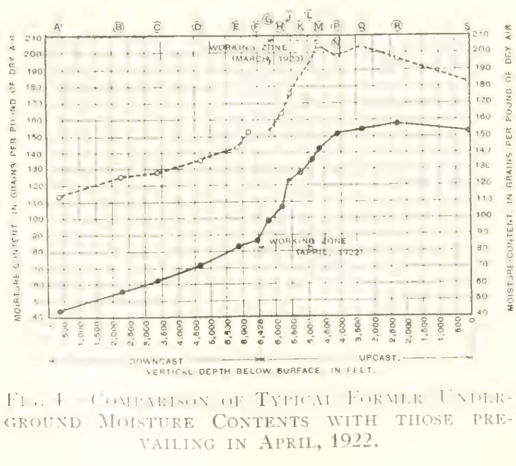


Fig. 4.—Comparison of Typical Former Underground Moisture Contents with those prevailing in April, 1922.

The steady wet-bulb temperatures now prevailing in the working zone will be seen to have a maximum value of 80·6° F, so that the wet-bulb temperature reduction caused there so far is at least 9·4° F, as compared with the former worst conditions, which, it is unnecessary to say, is, in its bearing upon the suitability or otherwise of the stope atmosphere for manual labour, a very considerable amount.

As regards Fig. 4, it may be noted that, so far as the downcast is concerned, the two curves are practically parallel, thus confirming the prediction made in the author's previous paper. As regards the upcast portion of the curves, the same rapid rise in moisture-content in the working zone takes place in both, but the saturation-point, at which condensation commences, is naturally reached considerably nearer the surface than used to be the case. It may be noted here that the relative humidity of the ventilating current decreases steadily at the present time from 100% on exit from the cooling plant (point A) all down the downcast, reaching Level No. 22 (point F) with a value of 37%, the minimum value (36%) being reached at point G. It then begins to rise rapidly, 100% being again attained at about Level No. 8 (point R).

The temperature observations illustrated by the diagrams were, for convenience and speed, not actually made on the stopes themselves, but at the intervening levels; hence the temperatures on the stopes were intermediate between those shown. In order to obtain more exact information as to the conditions there, additional observations have latterly been made at regular intervals on the stopes themselves, using the kata-thermometer; unfortunately, these could only be begun after the cooling plant had been started up, so that no direct comparison is possible with the previous bad conditions. But as the former wet-bulb temperatures and air-velocities are known, the former wet-kata cooling power can be calculated with fair accuracy by using the formulæ recently published by Dr. Leonard Hill. The author estimates that with a mean wet-bulb temperature on the stopes of 90° F, the average wet-kata cooling power obtaining there was 7·7 millicalories per second per square centimetre, with maximum and minimum values of 9·1 and 6·1. As the figure for wet-kata cooling power as being the minimum compatible with efficient working may be taken at 16, it will be seen that from this standpoint the stopes at Morro Velho were liable before the cooling plant started up to get into a very bad condition indeed, and it is probable that they never reached a satisfactory figure at any time during the summer months. At the present time, however, the average wet-kata cooling power on the stopes (excluding one abnormal point) reaches the high figure of 20·5, the maximum and minimum values being 24·3 and 16·8 respectively. The cooling plant cannot, of course, claim all the credit for this enormous improvement, for cooling power as measured by the kata-thermometer is dependent on air-velocity as well as temperature, and the velocity on the stopes, in common with that throughout the mine, is now 40% higher than it used to be, for reasons already given.

Another improvement directly due to the operation of the cooling plant is that which has taken place in the condition of the air blown by the auxiliary ventilation fans into the working-faces of the dead-end development drives at the lowest level. In support of this it may be mentioned that whereas wet-bulb temperatures between 91° and 92° F were frequently observed in the dead-ends at Levels No. 22 before December, 1920, nothing higher than 84° F has been read during the last six months. This is naturally a result of great importance, since the extension of the workings in depth depends entirely upon these drives and the speed at which they can be pushed forward.

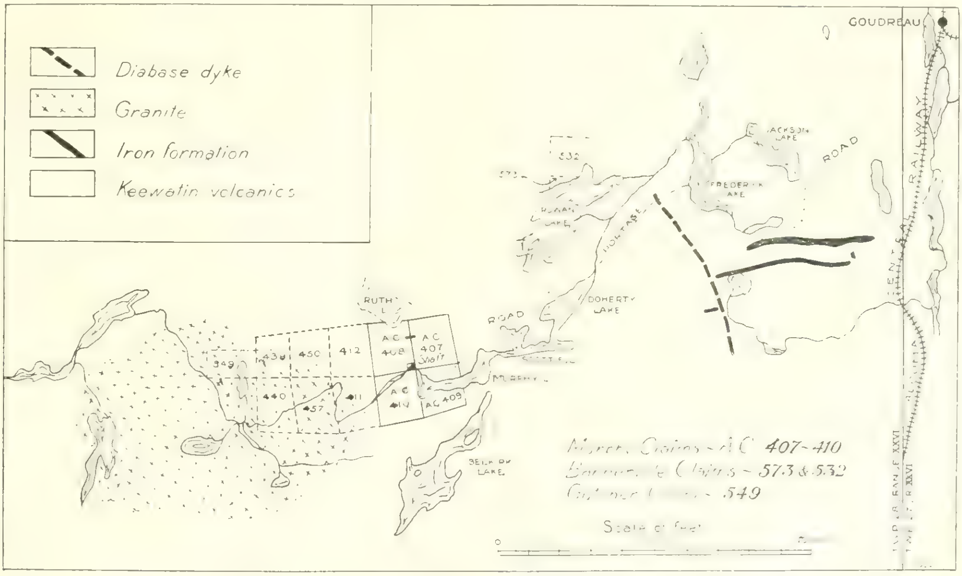
THE GOUDREAU GOLD AREA, ONTARIO

In September last we published an abstract of the report of A. G. Burrows for the Ontario Geological Survey on the gold discovery between Goudreau and Michipicoten Harbour, the latter being on Lake Superior. The *Canadian Mining Journal* for May 19 publishes a report on the district made by Dr. Ellis Thomson, who has made a further examination for the Geological Survey.

Gold was discovered in this district in 1918, but was at that time secondary in importance to the pyrites, both because of the smallness of the gold-bearing veins and because of the demand for pyrites. It was not until the discovery of the Murphy gold property in Township 28, Range 26 in the spring of 1921 that this region attained any prominence as a possible gold producer. The gold-bearing area is near the town of Goudreau on the Algoma Central Railway, some 177 miles north of Sault Ste. Marie, Ontario, and about 17 miles south of Franz, the junction-point of the Algoma Central Railway with the Canadian Pacific Railway. Gold has been found on both sides of the railroad, the older claims being to the east, the newer claims to the west of the right-of-way. The more important claims may be reached either by canoe route or by wagon road and are included for the most part in Township 28, Range 26 ; Township 27, Range 27 ; Township 26, Range 27 ; Algoma District. The contours in this comparatively small area are of the same character as in the rest of that district. Undulating country alternates with marshy ground, and the district is studded with lakes and streams. Most of the water to the west of Goudreau drains west into the Magpie River, while the streams and lakes to the east of Goudreau drain to the south and east into the Michipicoten River. The country on both sides of the Algoma Central Railway has been burnt at least once, and in several instances two or three times, and only second-growth poplar and birch remain for the most part.

The rocks in the district consist chiefly of acid and basic volcanics of the Keewatin formation, but these rocks have intercalated with them small bands of iron formation and are intruded by a boss of granite. All three of these formations are cut by diabase dykes of probably Keweenawan age which are so prevalent in this region. The latter have generally been intruded subsequently to the deposition of the gold ore, the veins being faulted by them in several places. The geological succession is briefly as follows : Pleistocene deposits, diabase dykes of probable Keweenawan age, granite, iron formation, Keewatin volcanics (acid and basic). The rock occurrences of the region may be summarized as in the following paragraph.

Diabase dykes are of two varieties, a younger containing olivine, and an older quartz diabase. The gold veins are usually unaffected by the former, but are sometimes faulted by the latter. The only granite in the area is a boss in the centre of Township 28, Range 26. Its close proximity to the Murphy gold vein would suggest its connexion with the deposition of gold in the vein. The granite is intruded in the diabase dykes, but cuts the Keewatin rocks. The iron formation's main characteristic is the predominence of siderite and pyrite in its composition. The gold values in this formation are found to be due to veins and veinlets of gold-bearing quartz that traverse it. The Keewatin volcanics, composing 80 to 90% of the rocks of the district, are of two distinct types, acid and basic. To the west of the Algoma Central Railway the basic types predominate, while to the east the acid flows are more common. The basic flows are, in the main, younger than the acid flows. They are mostly fine-grained volcanics with the original texture and composition of a basalt, but now very highly altered. In the vicinity of veins, the rock frequently contains biotite, quartz, muscovite, and occasional needles of tourmaline, as a result of the hydrothermal action to which the veins may be ascribed. In places the



MAP SHOWING CLAIMS IN GOUDREAU GOLD AREA.

usual basaltic character gives way to amygdaloids, vesicular lava, and tuff. The acid flows are mainly quartz porphyry and felspar porphyry, though there is a felsite in which some gold-bearing veins occur.

There are three distinct types of gold-bearing quartz veins in the district. These may be described as follows :—

(1) Shear veins, occurring along the planes of schistosity, mostly in the acid volcanic schists, where the greater fissility of the rock seems to induce their presence. They are composed mainly of quartz, with minor amounts of carbonates in places, and characteristically contain tourmaline, which indicates their hydrothermal origin. The shear veins are seldom larger than stringers, and are not often close enough together to make mining profitable.

(2) Cross veins, cutting across the plane of schistosity of the schist have two phases. Both are younger than the shear veins. The first variety occur mostly in the acid volcanics and in the iron formation, and contain pyrite and numerous black needles of tourmaline, in addition to gold. They vary in width from a few inches to two feet or more. On the McCarthy-Webb property in Township 27, Range 27, they may be seen of a length up to twenty or thirty feet. On the Gutcher claim veins of this type cut the granite, and are very irregular in length and width. They are of quartz, and contain pyrite, covellite, chalcopyrite, and muscovite, and a little gold. All veins of this type are too small and irregular to be mined separately, and are not sufficiently close together to provide paying ore.

(3) Fissure veins are found only on the Murphy claims. The main vein cuts across the strike of both acid and basic volcanic rocks. It is cut by a younger diabase dyke and faulted slightly by it, thus marking its age as greater than that of the dyke. The fact that there is a narrow band of iron carbonate formation along the vein for part of its length suggests that the two are of the same age. This vein, too, contains tourmaline.

The fact that the Keewatin rocks of this vicinity are surrounded by a large area of granite, and that a boss of granite protrudes in the centre, suggests that the Keewatin rocks are completely underlain by granite, being merely a comparatively thin covering over it. If this is assumed to be the case, then the flow of solutions through the cracks and fissures of the overlying Keewatin rocks would be a natural consequence of the last stages of cooling of the granite magma. The presence of tourmaline in most of these veins tends to support this theory. That native gold has been found on the Gutcher claim in quartz veins of the pegmatite variety cutting the boss of granite, would show that gold-bearing solutions were not foreign to the granite body during its period of cooling.

The author proceeds to describe the various workings and claims :—

The McCormick property, claim S.S.M. 2183, is about in the centre of Township 26, Range 27, east of Pine Lake. A pit 9 ft. deep has been sunk on a band of iron formation in basic volcanic rock. The iron formation, $2\frac{1}{2}$ to 4 ft. in width and 70 ft. long, contains pyrrhotite and quartz, as well as smaller amounts of chalcopyrite, pyrite, blende, and iron carbonate. Gold values in the pit are said to vary from \$46·60 on the surface to \$19·20 at a depth of 4 ft. No values of consequence have been obtained from other parts of the band of iron formation.

At the Fuller-Black, which adjoins the McCormick on the west, the gold-bearing vein is a small quartz stringer containing pyrrhotite, pyrite, and chalcopyrite, in addition to free gold. It occurs at the junction of acid and basic Keewatin volcanic rocks.

On the Cline, claim 2185, gold values up to \$6·00 are said to have been got from a band of sulphide-bearing basic volcanic rock at its contact with quartz porphyry. On claim 2186 adjoining 2185 on the east, four small pits have disclosed shear-veins and cross-veins carrying native gold, all in basic volcanic rocks. All are too small to be of commercial value. Claim 2189 is one claim east and south of the last. A pit 25 ft. deep has been sunk on some small quartz stringers said to carry values up to \$3,400 per ton. They cut both basic and acid volcanic rocks, and are cut by a diabase dyke.

The Webb, claim 2470, is in Township 25, Range 27. Discontinuous shear-veins occurring in the planes of schistosity of basic Keewatin rocks form a band said to extend for 1,700 ft. though only 200 to 300 ft. of this length was examined. Gold values have been obtained from this band, which is of irregular width.

The Webb-McCarthy, claims 2049 and 2050, are on the south boundary of Township 27, Range 26. In acid volcanic rock there is a zone containing numerous shear-veins and cross-veins, from 2 to 16 in. in width. Tourmaline, pyrite, and a little free gold are visible in the quartz of these veins.

The Banville-Page, claim 532, is on the north shore of Rowan Lake in Township 28, Range 26. Gold has been found in a contorted band of iron formation cut by numerous cross-stringers of quartz. The iron formation, 6 to 10 ft. in width, consists principally of quartz and iron carbonate, and occurs in basic Keewatin schist. Chalcopyrite and an occasional flake of gold are to be seen in the stringers of quartz.

Claim 549, the Gutcher, is in the western part of Township 28, Range 26. The gold-bearing veins, as already mentioned, are in the boss of granite that protrudes on this claim, and are evidently of pegmatitic origin. One vein, 1 to 3 ft. wide, and 200 ft. long, shows free gold in places, as well as considerable accounts of pyrite, covellite, and muscovite, and a little chalcopyrite, malachite, and ankerite. In a larger vein 12 ft. wide, no gold values were observed.

The Murphy, approximately in the centre of Township 28, Range 26, consists of claims 407, 408, 409, and 410. Most of the development work has been done on claim 408, near the north-east shore of Murphy Lake. The vein has been stripped for its entire length, 800 ft., and is from 1 to 10 ft. wide. It is composed of quartz, with numerous small needles of tourmaline, chalcopyrite, some bornite, pyrite, and blende, and native gold. The country rock on both sides is impregnated with quartz and metallic sulphides for a foot or more. Native gold has been found in numerous places along this vein, and a good showing was seen at the bottom of the pit, 20 ft. deep at the time of Dr. Thomson's visit. The vein on claim 408 is much the most promising in the district, and is the only one where gold values are at all consistent. As it is a fissure vein, it holds promise of values at depth.

The *Canadian Mining Journal*, in commenting on this article, says there has been a good deal of mining development since Dr. Thomson made his field examination, particularly on the Murphy

claims, where the descending shaft has disclosed remarkable gold values in the vein. The Goudreau Gold Mines, Ltd., which owns the Murphy mine, has completed the power line from Steep Hill Falls, and has about eighty men working. They are sinking two shafts. The No. 1 shaft is down 80 ft. or so, and is showing remarkable values. Every few feet they run into high-grade ore. The shaft is going down near a diabase dyke. About a thousand "snow-shoe" claims have been staked during the winter, and there are now at least five hundred prospectors in the new field. Judging from the information at present available, it is reasonable to conclude that the only prospect in the Goudreau district that gives promise of making a paying mine is the Murphy.

INCLINE SLICING METHOD OF MINING LARGE ORE-BODIES

In our March issue an article by J. Parke Channing was quoted dealing with caving systems of mining. In this article Mr. Channing expressed a doubt as to the adaptability of the incline slicing system to large blocks of ore. A reply to this opinion is given in the *Engineering and Mining Journal-Press* for May 27 by J. P. Hodgson and John Kiddie, who describe the progress which has been made in the adoption of this method in the Morenci district, Arizona. The method was started at the Coronado mine of the Arizona Copper Company, and later applied at the Humboldt mine of the same company. The mines now belong, as readers are already aware, to the Phelps Dodge Corporation. The general scheme of preparatory work and the method of operation of incline slicing at the Coronado mine, in stoping a long and comparatively narrow vein, has been described in a paper contained in the *Transactions* of the American Institute of Mining and Metallurgical Engineers for 1917. Owing chiefly to the satisfactory results obtained at Coronado, the incline slice was introduced in the Humboldt mine, at Morenci, in 1918. Subsequently, several flat slicing stopes have been changed to the incline system. At the Humboldt mine the incline slice method was tried out in stope No. 36, in a block of ground extending 55 ft. in height above the Humboldt adit level. This stope had been previously mined down from the capping, for a distance of 44 ft., by brow caving, on two floors; and below this, by flat slicing for 55 ft., by five slices each 11 ft. in height. The incline slices were started under this flat mat, and have been continued, until at present a maximum vertical distance of 77 ft. has been removed by this method.

Fig. 1 shows a plan of the two largest incline slicing stopes of the Humboldt mine. These stopes are respectively 230 by 750 ft. and 285 by 420 ft. in area. The preparatory work in No. 34 stope consists of blocking out the area to be stoped by parallel raw drifts spaced at 50 ft. centres. Each drift has a timbered rise at its extreme east end, 55 ft. in height, and raw rises at 15 ft. intervals, 44 ft. high, for its entire length. One extra finishing rise, also raw, is placed to the west of the stope, outside the actual stoping area. A large haulage drift for supplies, to the west of the stope, is connected to each of the cross drifts. The incline slices begin at the east side of the stope, as shown, and are carried back over each drift, with the rises forming the centre line of the slice. The over-all width of these slices is 50 ft. By this method of blocking out,

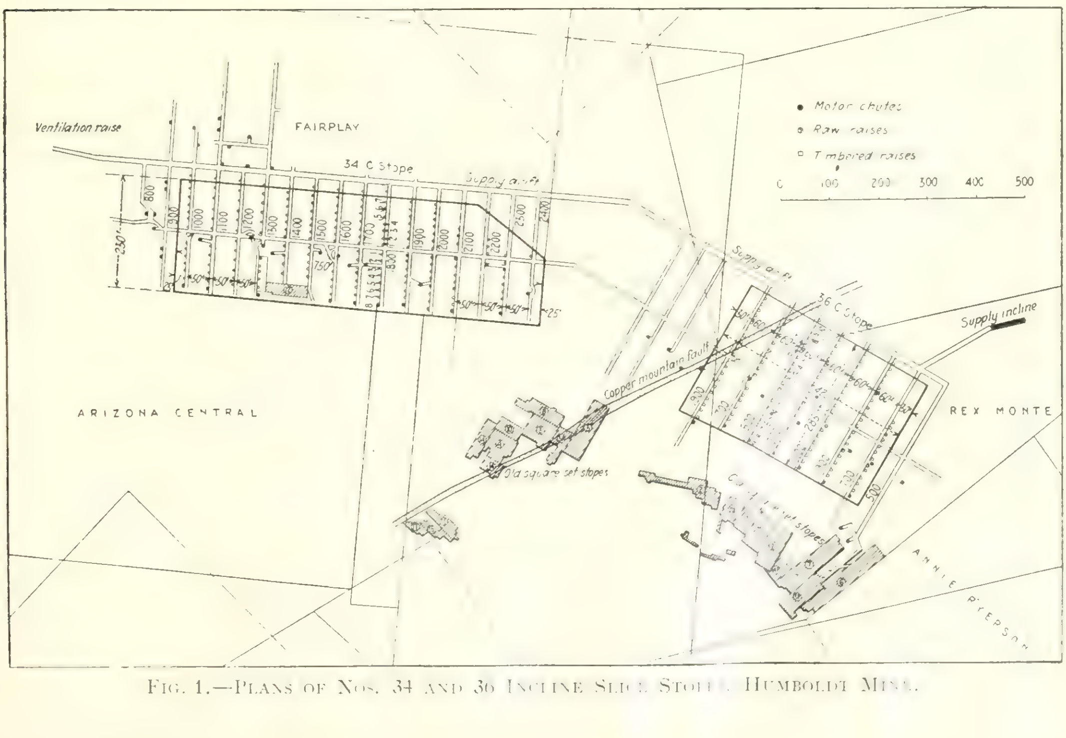


Fig. 1.—Plans of Nos. 34 and 36 Incline Slice Stopes, Humboldt Mine.

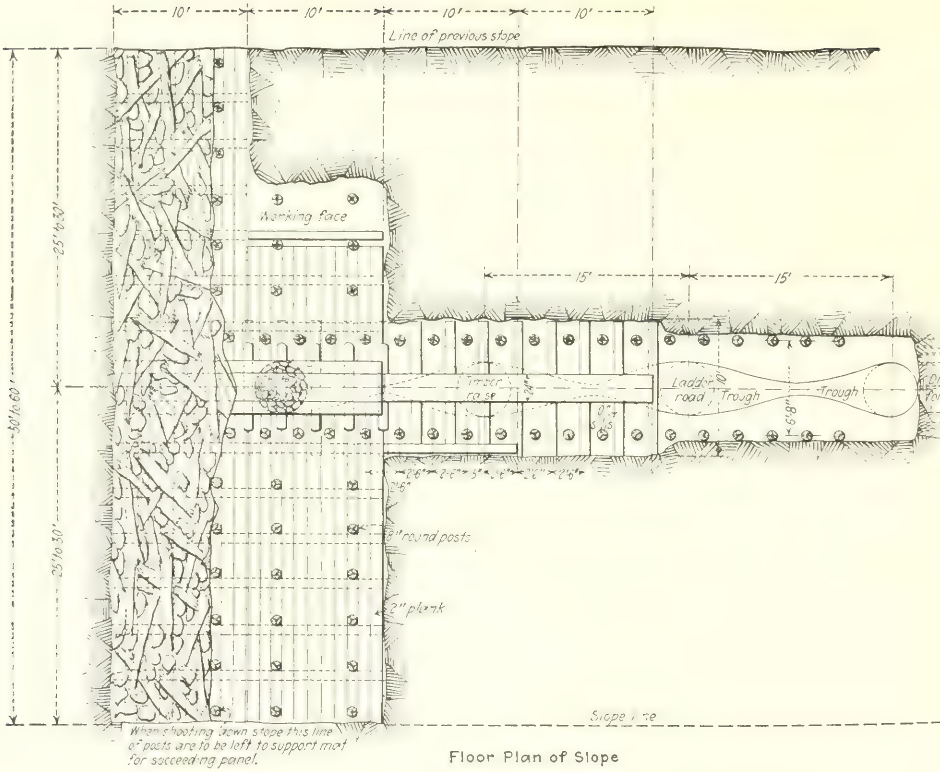


FIG. 2.—PLAN ILLUSTRATING INCLINE SLICING METHOD.

approximately 53 tons of ore is stoped per foot of preparatory work.

In No. 36 stope the drifts were driven with 60 ft. centres to conform to the work already done on the adit level, 55 ft. above. In other respects the blocking out is similar to that described. By this arrangement 65 tons is stoped for each foot of preparatory work.

In the stopes described, the slices were taken across the ore-body, making their total lengths 230 ft. and 285 ft. respectively. It was necessary to lay out the areas as indicated, on account of the stoping already in progress on the adit level, as a continuous production of ore had to be maintained during the period of change. Had no previous work been done in the ore-body, it would have been feasible to run the slices parallel to the long axis of the ore, making them 750 ft. and 420 ft. respectively. This latter system would necessitate laying out the stoping drifts 50 ft. apart for the full lengths of the ore-bodies ; for handling supplies and men, it would be necessary to drive several cross drifts. Inasmuch as the time of maximum trouble and minimum production from any particular slice is during the starting period, there are distinct advantages in making the slices as long as possible.

Figs. 2 and 3, above and on the opposite page, show the method of stoping, which is similar to that described in the previous papers, differing only in some of the details. The present modification has been developed to facilitate the shooting down of sections as the panels, or wings, are completed. In this way the mining of the wings can be done by the bonus or contract system, rather than by day's pay.

It has been found that stopes of 50 ft. width have an advantage over those of 60 ft., as the ventilation at the extreme top of the wings in the 60 ft. slices is not as good and interferes with the efficiency of the workmen. In the stopes shown in Fig. 1, the ore is hand-trammed in one-ton cars on the sub-level to motor chutes. In No. 34 stope one motor chute is situated between each two drifts. In No. 36 stope a separate motor chute serves each drift. The possibility of eliminating the hand-tramming should be considered, particularly in ore-bodies which are continuous from the stope floor to the main haulage drift.

The chief difficulty encountered in stoping by the incline method has resulted from the presence of old motor tunnels on the adit level. These tunnels are large in cross section, and as the slices come down to the level it becomes necessary either to fill them by hand or to hold them open, as the conditions require. Both operations are not only expensive but also interfere with production.

Prior to the time when the stope approached the adit level, it was possible to install a gang bonus, with results mutually beneficial to the company and the men. The bonus was in force eight months, and during that time an average of 10·6 tons per stoping man was obtained, covering a total extraction of 94,000 tons of ore.

The comparison of costs between the incline slice method and the flat slice system shows a reduction of 15% in favour of the incline method for the four years 1918 to 1921, and proves that the application of the incline slice in these properties, to large ore areas, has been successful.

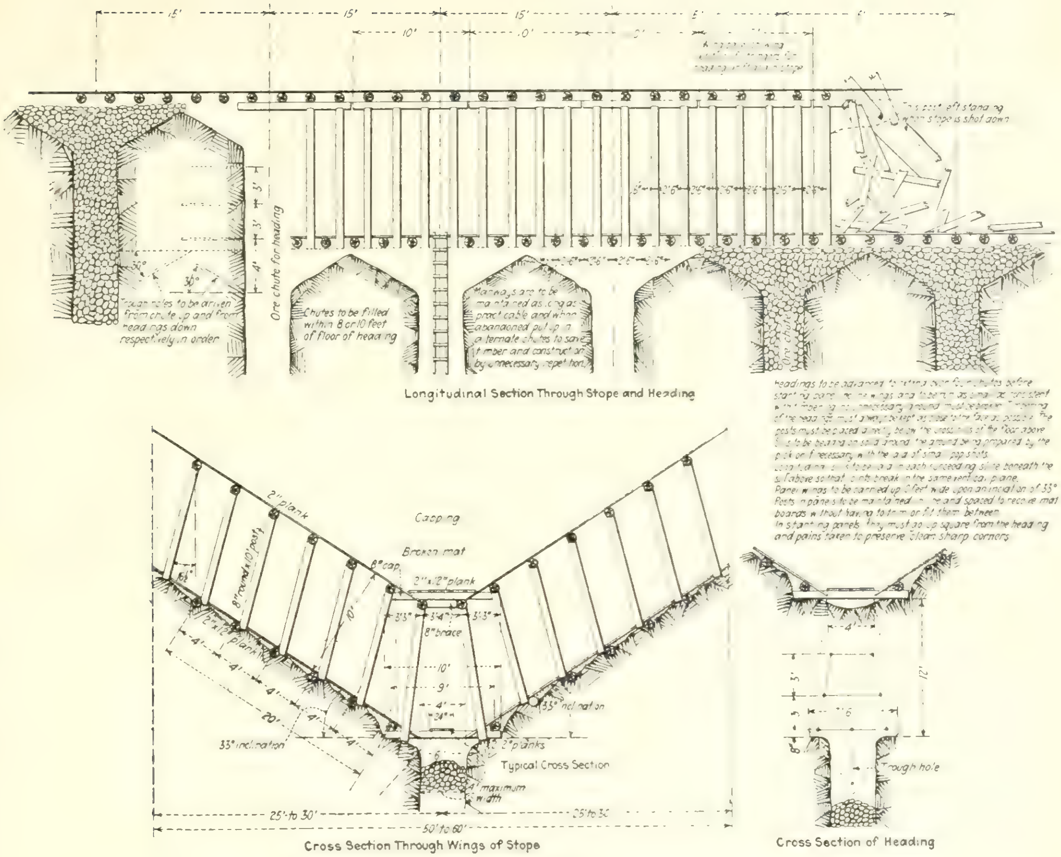


FIG. 3.—CROSS-SECTIONS ILLUSTRATING INCLINE STOPING METHOD.

Corundum in the Transvaal.—The *South African Journal of Industries* for April contains a paper by A. L. Hall, Assistant Director of the Geological Survey, on the new corundum industry in the Zoutpansberg district of the northern Transvaal. We quoted Dr. P. A. Wagner's article on these deposits in the MAGAZINE for September, 1918, and mention was made in our issue of February, 1921, of Mr. Hall's monograph dealing with the geology of this district. The present article deals with the work done by Zoutpansberg Corundum, Ltd.

When during the war there suddenly arose an urgent demand for large supplies of raw material for the manufacture of all kinds of abrasive tools, South Africa responded to the call, and a vigorous industry rapidly sprung up in the north-eastern Transvaal, where corundum was located and developed on a large number of farms, almost exclusively by surface work only. At the height of this activity during 1918 the export reached the total of 3,875 tons. The recovery of this material was achieved by somewhat primitive methods, and preparation for the market did not go beyond the process of washing in rotary pans. In all cases the corundum was exported in the same physical condition as it was found, either in the form of the so-called "boulder corundum" or else as a kind of coarse gravel of irregular crystals.

The Transvaal corundum fields extend over some 2,000 square miles of country in the Zoutpansberg and Pietersburg districts, the most productive portions lying between Zoekmakaar and Louis Trichardt, more particularly round Bandolier Kop and in the low country east of the Selati Railway. The corundum is found both in the eluvial form (crystal corundum) and in a massive form of boulder corundum which consists of a mixture of felspar and corundum. When found *in situ* the ore forms thin vertical reefs in contact with magnesian igneous rock.

The fear that at the conclusion of the war the activity in the South African corundum fields would be followed by a severe reaction proved justified by subsequent events, for soon after peace was declared there was a heavy fall in the demand as the result of changed economic conditions. The main reasons for this set-back lay in large accumulations of corundum remaining on hand after the war, in renewed competition between natural and artificial abrasives, like carborundum, and in the special conditions under which the local corundum industry has arisen. The urgency of the demand during the war did not, in fact, tend to very high and uniform standards of quality or methods of market preparations. To-day, the keen competition requires changed methods of recovery and grading, high uniform standards, and guarantees of continued large outputs satisfying the most rigorous

requirements of manufacturers. This can only be achieved by carefully prepared grain corundum of approved composition. Corundum being a heavy mineral and associated with relatively light matter such as felspar and mica, there appeared no reason why the concentration of corundum should not be effected by ordinary mechanical methods. This principle was adopted by the new company, Zoutpansberg Corundum, Ltd., and it was tested first at the Zaaiplaats tin plant, and afterwards at a plant erected at the company's mine near Bandolier Kop. With this plant it has been demonstrated that superior grain corundum of marketable quality can be economically produced in the Transvaal fields by methods much less elaborate than those that were in use at the famous Craigmont mill in Canada.

The main mine of this company lies about 400 ft. from the grinding mill and about 3 miles due west of Bandolier Kop on the farm Turkaspost within a few yards of its common boundary with the adjoining farm Bultfontein. Both these properties contain large deposits of corundum-bearing rock, in reef as well as in eluvial form. At the main mine the reefs are opened up in a series of surface workings consisting of irregular pits, wide trenches, and short cross-cuts, exposing solid reef down to the maximum depth so far reached, 60 ft. The ore forms vertical bodies up to 12 ft. thick and composed of coarse white plumasite (felspar-corundum rock), carrying from 15 to 60% of corundum, the remainder being almost purely felspar, but with a little black mica, magnetite, etc. In addition to the farms mentioned, the company controls further supplies from eleven other properties in close proximity. The water supply comes from a bore-hole 500 ft. from the mill and furnishing not less than 180,000 gallons per day; this is ample for all milling operations. A 45 h.p. gas engine generates power for pumping water, running the mill, and working the dynamo for the magnetic separator and for electric illumination.

From the mine the ore arrives at the mill as coarse gravelly material mixed with earthy débris, but including larger blocks; the latter are reduced to about half the size of a fist by means of a 12 in. stone-crusher. The ore is then crushed by five stamps weighing 1,500 lb. each, the product passing out through an eight-mesh screen to a Frenier pump. The pump lifts the crushed material to a Callow screen, in which a screen of twenty-mesh furnishes an oversize and undersize. The oversize passes to a three-compartment Hartz jig, in which the receiving compartment furnishes pure corundum, to be drained into settling-vats, then dried, and finally passed to the magnetic separator and classifier. The middle compartment produces less pure corundum, to which felspar still adheres; these middlings are returned to the stamps. The third compartment gives almost pure felspar as waste. The undersize from the Callow screen goes to spitzkasten, thence to two Wilfley tables, and, after drying, to the magnetic separator and classifier. Slimes from the Wilfleys go to settling-pits, whence the clear layers of water again circulate through the mill. The concentrates both from the jig and Wilfleys are transferred to the magnetic separator, for the removal of iron and titanium. Here two endless canvas belts pass between a powerful electromagnet, so that the magnetic particles are attracted to the upper belt and thrown out, while the corundum remains on the lower belt, and is automatically discharged on to the classifier. This is a long gently inclined pulsating framework, of various size screening, the finest type of screening being situated next to the discharging belt, and the coarsest type at the lower end of the inclined frame. Along one side of the latter streams of graded corundum are discharged separately from their corresponding screens. By inserting a number of screens of suitable mesh, fifteen distinct grades are recovered, ranging from 10 to 100 mesh. The product is finally put up in double bags holding 112 lb. of grain corundum each, ready for the market. Running nine hours per day, the daily output of graded grain corundum is from 2½ to 3 long tons. The average analyses show 95 to 96% Al_2O_3, 1 to 2% SiO_2, 1% Fe_2O_3, and 0·1% TiO_2. The price at Bandolier Kop is £20 to £23 per ton; in London £10 more.

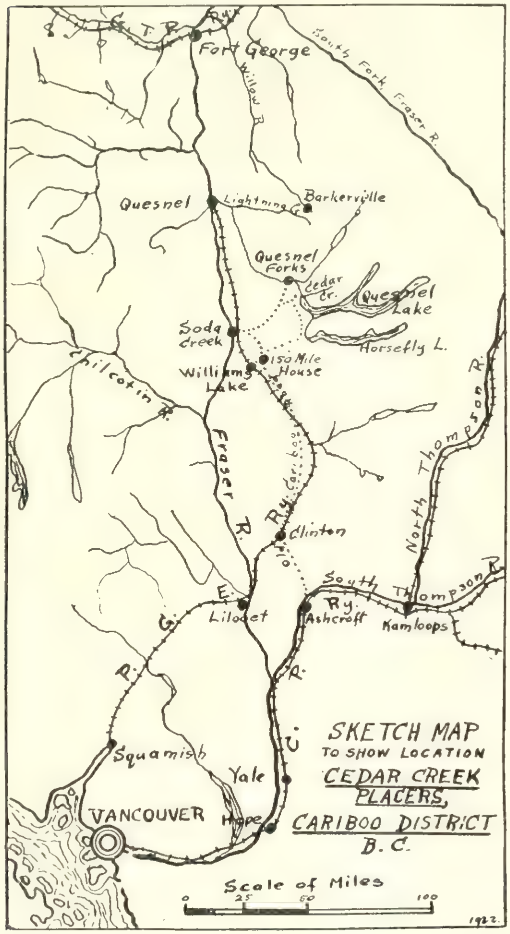
The present supply of ore comes from the main mine, in which the reef is up to 12 ft. thick, and is continuous vertically down to the maximum depth of 60 ft. so far reached. Between this mine and the mill are several workings exposing further bodies of reef with thicknesses up to 8 ft. In addition there are three further reef workings on Turkaspost and Bultfontein, while across the common boundary of these farms is a large area of proved eluvial corundum not less than 400 ft. by 200 ft. in extent. Additional occurrences, both in reef and eluvial form, have been opened up on Rouwput, Silverbank, and other farms belonging to the company.

Prospecting in Cariboo, B.C.—The *Canadian Mining Journal* for June 2 contains a paper by W. A. Johnston, of the Geological Survey of Canada, on the Cariboo district, British Columbia. The recent discovery of placer gold on Cedar Creek, in the Quesnel district, is drawing prospectors once more to Cariboo, the oldest and most famous of the goldfields of the Province. The author of the paper examined parts of the district in 1921.

Cedar Creek is a small stream flowing into Quesnel Lake from the east, about 3 miles above the old dam at the foot of the lake. It was first ascended by a prospecting party in 1862, but apparently because of the important discoveries in the deep ground of Williams Creek, early in that year, was abandoned until 1865. The discovery of Cedar Creek was credited to J. E. Edwards, one of the prospectors of the famous Aurora claim at the mouth of Conklin gulch, a tributary of Willaims Creek. The Cedar Creek diggings proved to be valuable, yielding steadily as well as largely for some time. Bancroft states in his history of British Columbia that the Aurora claim, with flumes and sluices costing $8,000, yielded mostly in 1866, $20,000; the Moosehead claim, costing $2,000 to open, paid $7,000 the first year; the Barker claim also located in 1866, and costing $7,000 to open, paid $2,000 in a year; and the Discovery claim was yielding in September, 1866, $15,000 to $20,000 a day at a point where it was shallow. These claims were apparently all in the bed of the creek; the part found to be gold-bearing extended upstream about 1½ miles from the mouth. In September, 1867, both the Aurora and Discovery were averaging $20 a day to the pan. The Aurora Company in July, 1867, completed a flume 2,000 ft. in length, dumping into Quesnel Lake. Some of the ground on the bedrock yielded $2·25 to the pan and the pay dirt was from 6 to 8 ft. thick. G. M. Dawson states that in 1886 the creek was largely in the hands of Chinese miners who worked it for several years by the hydraulic method on a fairly large scale. Coquette Creek on Poquette Creek below Cedar Creek on the same side was also

found to be gold-bearing in 1866. It was worked by the Chinese for several years. Several bars on the south fork of the Quesnel and near the forks were rich. Roses gulch on the east side between the forks and the dam and the famous buried channel known as the Bullion property on the west side have been worked for many years.

It is important for present day prospectors to know that in the 60's several thousand prospectors,



many of whom were energetic and capable, were in Cariboo district and pretty thoroughly tested very many of the creeks. There are comparatively few creeks in the region in which careful search will not reveal traces of the work of the early prospector. The present-day prospector should search carefully for traces of old workings before sinking expensive shafts, and he may be fairly certain if he finds them that the ground was well tested in the early days, unless it was deep or the water pressure was excessive. It is true, however, that the early prospector's efforts were largely restricted to testing the ground on the bars and in the beds of the present creeks, and that only a few benches or high-level channels were found or were searched for. The recent discovery on a bench or high-level channel 600 or 700 ft. above Cedar Creek shows that such channels do occur, and these are the channels the prospector should search for particularly.

The stream valleys in the Quesnel Lake and Quesnel River sections of Cariboo are frequently steep-sided and 300 to 500 ft. or even more in depth, and parts of them are of different character and of different ages. The newer, lower channels are narrower and have steeper sides than the older high-level channels, of which only fragments, as a rule, remain, for they have been in part cut away by the streams that have formed the new channels. In attempting to locate and trace the high-level channels and benches, the surface of the bedrock should be considered rather than the surface of the drift; for this may fill inequalities in the surface of the bedrock, and be itself in the form of terraces. The old channels are partly confined to the valleys of the present streams and occur as benches extending for short distances along one side or the other of the present valleys. If the old channel was gold-bearing, the present creek will be enriched in the parts beneath where the old channel crossed from one side to the other, or, in other words, where the present channel has been cut down beneath the old channel. Some of the old channels may be independent of and cut across the present channels, and the streams in the old channels may have flowed in different directions from the present streams. The direction of flow of the old stream is occasionally indicated by shingling in the gravels, that is, the stones overlap downstream and dip upstream. The gradient of the ancient channels was probably only a few feet to the mile, so that if one portion is found, its extension should be looked for at nearly the same level.

Another factor of importance in the Quesnel River area is the presence of lava flows and the possibility that gold placers are buried beneath them. The lava flows do not occur in the Barkerville area, but are exposed near Quesnel Forks, along the trail leading to Quesnel Lake, and at other places along Quesnel River. They are probably mostly of Tertiary age. It is possible that in places they fill ancient valleys, and overlie gold-bearing gravels, as is the case in California, but no important discoveries of this character have been made up to the present in British Columbia so far as known. The lava-buried gravels can be prospected only in those places where the streams have cut through the lava, and these places are not numerous. A few occur in the vicinity of Quesnel Forks, and doubtless at other places, and are well worth investigating.

The facts that discoveries of placer gold have been made in recent years in parts of the Cariboo district, which were supposed to have been thoroughly prospected in the early days, and that some of these discoveries are in high-level channels which were not recognized formerly, show that the area is still worthy of careful prospecting. The Quesnel Lake and Quesnel River section is easy of access, but is difficult to prospect because of the dense covering of timber and underbush, which renders travelling away from the trails difficult; but for this reason it has probably not been as well prospected as other parts of the region.

Platinum - Palladium Assay. — In the investigation of methods for assaying platinum conducted by the United States Bureau of Mines, recent experiments have shown that with certain ores, especially when the quantity of platinum is considerable, nitric acid will not effect a separation of platinum and palladium. The following method has been found to be accurate, and to result in a

complete separation of these metals. It is a development of the methods described by Wunder and Thuringer in German periodicals published in 1912 and 1913. These investigators devised methods for the separation of palladium from all the platinum metals except platinum by means of dimethylglyoxime. They state that there is no action for several hours if an excess of dimethylglyoxime is added to an aqueous solution of chloroplatinic acid in the cold, also that only on boiling is the platinum precipitated and then only part of the platinum is removed from the solution. They found that palladium is precipitated quantitatively in the cold as $C_8H_{14}N_4O_4Pd$, which is insoluble in water, dilute hydrochloric acid, dilute acetic acid, or in 50% ethyl alcohol. All of their precipitations were carried out while the solutions were being heated. This caused a partial precipitation of the platinum along with the palladium.

A few preliminary tests at the Bureau Laboratory substantiated the belief that palladium could be precipitated free from platinum if a solution of the chlorides of these metals be treated at room temperature with an alcoholic solution of dimethylglyoxime. The following procedure was worked out to separate and determine platinum and palladium quantitatively. The platinum and palladium free from the other platinum metals are obtained by the method given in the Bureau of Mines Technical Paper 270. These metals are ignited and cooled in an atmosphere of hydrogen and weighed together. The weighed metals are dissolved in a little aqua regia and evaporated just to dryness. The residue is moistened with a drop of hydrochloric acid, and after the addition of a little distilled water, a solution of dimethylglyoxime is added, drop by drop, with constant stirring until there is no further precipitation. After standing at room temperature for a few minutes, the voluminous yellow precipitate is filtered off, washed thoroughly with distilled water and ignited slowly and carefully, first in air to drive off organic matter, and then in hydrogen to reduce any oxidized palladium to the metal. The metallic palladium is then weighed. The platinum may be found by difference or it may be recovered and weighed. To recover the platinum the filtrates from the palladium precipitation are carefully evaporated to dryness in a small pyrex beaker or porcelain dish, a little nitric acid being added as the volume becomes small. The residue is heated almost to redness to drive off all organic matter, the presence of which would prevent the complete precipitation of platinum. The residue is extracted with a little aqua regia, is evaporated just to dryness, is extracted with a drop of hydrochloric acid, and is diluted with a little distilled water. The solution is made alkaline with sodium carbonate, acidified with an excess of formic acid, and boiled to precipitate the platinum, which is filtered off, washed, ignited, and weighed.

Further details are given by the Bureau Assistant Chemist, C. W. Davis. The dimethylglyoxime solution is prepared by dissolving one gram of dimethylglyoxime in 100 c.c. of 95% ethyl alcohol. If the palladium content is high it may be necessary to dissolve the recovered palladium in nitric acid, take to dryness with hydrochloric acid, take up with a drop of hydrochloric acid and a little water, and again precipitate the palladium with dimethylglyoxime solution. Any platinum that may have been occluded in the first precipitation is now in the filtrate from the second precipitation, and is recovered in the same way, by evaporation, ignition, solution, and precipitation. If the palladium content is low (less than 0·5 mg.), it is advisable to add only a few drops of water to the platinum-palladium chloride residue that has been moistened with a drop of hydrochloric acid and then to add a few drops of the dimethylglyoxime solution. This procedure will hasten the precipitation of the palladium and cause it to form in a coagulated condition. The use of cut-down funnels and filter papers is desirable when small amounts of palladium are encountered. Alundum boats and a tube combustion furnace are convenient for igniting the palladium.

Tungsten Deposits from Springs.—In *Economic Geology* for May, Waldemar Lindgren gives an account of a mineral deposit precipitated from a hot spring in Bolivia some distance below the Uncia tin mine. The interesting point of this deposit is that it contains tungstic acid on analysis. This evidence is of value in the consideration of the carriage of tungsten compounds in solution and their precipitation, when discussing the theories of the origin of ore deposits.

The hot water issues from several vents a few metres above the bottom of the valley, in which a small water-course flows over slate bedrock. The quantity of water is at least 150 gallons per minute, perhaps considerably more. At one place a small geyser cone about 0·8 metre high and one metre in diameter has been built up of calcareous tufa. The water has a temperature of about 60° C., and is slightly salty to the taste. It appears to contain a little H_2S but not much CO_2. The deposits of the springs are predominatingly calcareous and extend from the creek upward over the gentle valley slope for at least 10 acres and possibly more, and reach an elevation of at least 30 metres above the creek. It is evident that the springs have occupied this position for a long time, and that the orifice has been lowered as the erosion proceeded. The larger part of the spring deposit consists of a rather compact light yellowish-grey calcareous tufa in rude horizontal beds. There are also minor beds and lenses of flinty brown streaked opal. This material contains small dark-brown masses of manganese dioxide and small streaks of crystalline barite and calcite. The tufa in many places contains patches of dark brown to black earthy matter also rich in manganese, and these sometimes form larger lenses of porous black manganese ore, rarely more than a metre in thickness. This is often roughly bedded by the intercalation of thin streaks of white crystalline barite.

The little geyser cone consists of a porous and cellular calcite, stained a dirty greyish brown It also contains considerable silica probably in the form of opal. The brownish stains gave strong reaction for manganese, but contain little or no iron. The spectroscope showed a strong reaction for lithia. The bedded material of barite, calcite, and manganese ore was examined in thin sections and polished sections. The latter show the manganese mineral to be normal psilomelane in rounded mammillary forms ; this evidently is a colloidal deposit, which has now become hardened and has acquired a fibrous structure. No other minerals were found. A qualitative analysis showed a little silica, not much lime, but large quantities of barium oxide, sulphur trioxide, and manganese. There were also traces of copper and lithium. A notable quantity of tungsten, at least 0·5% of WO_3, was present. Assays for silver and gold proved negative

except in the case of the brown opaline sinter which gave a fraction of an ounce of silver to the ton.

The definite discovery of tungsten led to many further tests for this element. There was little or no tungsten in the purer calcareous and siliceous materials, and it was soon found that the metal was dependent upon the quantity of psilomelane present. Pure pieces of this mineral always gave a strong test for tungsten, but apparently this metal is not uniformly distributed. One specimen gave an amount of tungsten which must have represented several per cent. It is concluded that the tungsten is not present as any definite mineral but was precipitated as a colloid together with the manganese dioxide. If this is true it follows that concentration processes will be of no avail and that the only way to utilize the material would be by aid of chemical processes similar to those followed by the qualitative analysis. It would, therefore, seem that in spite of a noteworthy amount of tungsten present, perhaps averaging 0·5%, the ore has no economic value, certainly not at present.

The geological map of the departments issued by the Bolivian government shows the position of many hot springs. Their positions appear to correspond roughly to the extent of the great rhyolitic flows in the departments of Oruro and Potosi. Among the more northerly are the hot springs of Huanuni and Uncia. Another group is situated about 50 miles further south near the mines of Avicaya. Still another group are situated in the vicinity of Potosi. Considering the scarcity of hot springs elsewhere it is well permissible to see in this arrangement a genetic relationship with the rhyolite eruptions, and further investigations of the deposits of these springs might produce interesting results.

Tungsten is now definitely added to the metals carried by hot springs. As is well known the tungsten and tin deposits of Bolivia are intimately associated as to genesis. Thus far no tin has been reported in the waters or tufas from Bolivia, but traces of this metal have been shown to exist in the waters of certain thermal springs of the Rhine region. It will also be recalled that Meunier reported tin from a sinter deposited by a spring in Malaya, though from some sources doubt has been cast on this occurrence. According to a private report by Dr. Koeberlin, some of the Bolivian springs issue from a fault plane which has a vertical throw of more than 1,000 metres; this probably extends to great depth and may establish some form of connexion between the surface and the rhyolitic magma. The deposits consist of alternating layers of tufa and siliceous material. Especially the calcareous layers are strongly coloured by manganese oxide; in these manganiferous lime rocks tungsten has been found up to 4% of WO_3. The thickness of the deposit is at most three metres, and the average tungsten content is 0·5% WO_3.

SHORT NOTICES

Harvard Mining School. — In the *Engineering and Mining Journal-Press* for June 3, G. J. Young describes the 4 and 5 year mining courses at Harvard University.

Mine Cars.—At the meeting of the Mining Institute of Scotland held on June 10, John Wilson read a paper on the resistance to traction of mine cars.

Mine Supports.—At the meeting of the North of England Institute of Mining and Mechanical Engineers held on June 9, John Roberts read a paper on the development of metal supports for mines.

Hammer Drills. — In the *Colliery Guardian* for June 2, G. Hooghwinkel describes the Titan pneumatic pick with particulars of results obtained in German collieries.

Drill-Steels.—In the June *Bulletin* of the Canadian Institute of Mining and Metallurgy, H. V. Haight discusses the cross sections of hollow drill-steels and recommends a steel which he calls "fluted," similar to the cruciform, but with the furrows partly filled by segments of a circle concentric with the hole.

Air-Compressors.—At the Paris meeting of the Institution of Mechanical Engineers held on June 14, William Reavell read a paper on air-compressors.

Pumps.—The *Colliery Guardian* for June 9 describes the Boonzaier valveless reciprocating pump. It is applicable to bore-holes and deep wells.

Tube-Mills—The June *Bulletin* of the Canadian Institute of Mining and Metallurgy contains a paper by H. E. T. Haultain and F. C. Dyer, describing investigations into the paths of balls in tube-mills. This paper is accompanied by an elaborate series of photographs illustrating the course of the balls in a specially designed tube-mill.

Flotation of Coal. — In *Chemical and Metallurgical Engineering* for June 7, O. C. Ralston and G. Yamada describe flotation tests on bituminous coking coal. A previous article on this subject appeared in the same journal for March 15.

Chloridizing Volatilization.—In the *Engineering and Mining Journal-Press* for June 3, Rudolf Gahl discusses the problem of heat requirements in the process for chloridizing volatilization and the consumption of fuel.

Determination of Uranium.—The *Journal of Industrial and Engineering Chemistry* for June published a paper by W. W. Scott, describing his glacial acetic method for determining uranium in carnotite.

Mount Bischoff Tin.—*Economic Geology* for May publishes a paper by J. G. Weston-Dunn on the economic geology of the Mount Bischoff tin deposits, Tasmania.

Keno Hill.—In the *Engineering and Mining Journal-Press* for June 17, C. F. Wilson gives particulars of the Keno Hill silver-lead developments, in Mayo district, Yukon Territory.

Sulphur in Chile.—In the *Engineering and Mining Journal-Press* for June 10, H. G. Officer describes native sulphur deposits in various parts of Chile, mostly in the neighbourhood of volcanos.

Geology of the Rand.—In the *Geological Magazine* for June, Dr. F. H. Hatch gives a historical account of the investigations in connexion with the geology of the Far East Rand.

New Cornelia Copper.—In the *Engineering and Mining Journal-Press* for June 3, A. W. Allen commences an article on the Ajo mine of the New Cornelia Copper Co., Arizona, giving particulars of the geology, mining, and hydro-metallurgical treatment.

Horace V. Winchell.—The *Engineering and Mining Journal-Press* for May 27 contains a biographical notice of Horace V. Winchell, a distinguished member of a family of geologists, known for his work in connexion with iron and copper deposits in the north-west of the United States. He was president of the American Institute of Mining and Metallurgical Engineers in 1919.

RECENT PATENTS PUBLISHED

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.*

30,507 of 1920 and 20,207 of 1921 (179,201). W. H. Dyson, Guildford, and L. Aitchison, Birmingham. Chemical process for removing certain metallic constituents from ores by treating them with chlorine or hydrochloric acid gas at elevated temperatures, thus converting the metals into volatilizable compounds.

1,588 of 1921 (157,860). L. Clerc and A. Nihoul, Paris. Method of making zinc sulphide pigment by reaction with zinc carbonate which has been formed by passing carbonic dioxide into a solution of zinc chloride in the presence of magnesia.

2,104 of 1921 (161,156). New Jersey Zinc Co., New York, and J. A. Singmaster, Palmerton, Pa. Improvements in the method of producing zinc oxide by burning volatilized zinc.

2,592 of 1921 (179,992). W. B. Ballantine, London. Method of making ferro-chrome high in chromium and low in carbon.

3,159 of 1921 (180,384). P. Freedman, London, and E. Greetham, Hull. Electric furnace for reducing metals such as zirconium, cerium, and uranium from their oxides.

3,481 of 1921 (171,962). Rheinisch-Nassauische Gesellschaft and A. Spieker, Stolberg. Increasing the metallic content of zinc dust by dissolving the oxide with acid.

3,964 of 1921 (179,299). W. W. Richardson, London. Improvements in the inventor's methods of extracting metal from alluvium by passing it through a revolving concentrator.

4,188 of 1921 (159,143). W. E. Trent, Washington. Process for sintering fine ores.

4,360 of 1921 (158,887). G. Haglund, Falun, Sweden. A process for the treatment of copper-nickel matte comprising the following operations: Converting the matte until the main part of the nickel has been changed to the metallic state, dissolving a portion of the matte by percolation of acid in the presence of air, cementation of the solution thus obtained by means of another quantity of matte until a nickel solution free from copper is obtained, recovering nickel from this solution, roasting the undissolved residue from the acid treatment together with the undissolved residue from the cementation process, leaching the copper-nickel oxides thus obtained with acid, reducing the undissolved oxides to metal and recovering the precious metals therefrom.

5,068 and 5,899 of 1921 (180,021). W. G. Perkins, London. A method of concentrating carbonate or oxides of copper by heating the ore with pyrites in a non-oxidizing atmosphere, so producing a magnetic compound which may be removed by magnetic concentration or by flotation.

5,108 of 1921 (160,454). G. P. Guignard, Melun, France. Method of recovering ammonia and hydrocyanic acid from compounds of titanium with nitrogen and cyanogen.

5,112 of 1921 (179,675). General Electric Co., Schenectady, New York. In producing laminae of iron electrolytically the use of a cathode high in tungsten or molybdenum.

5,120 of 1921 (160,760). C. A. Stevens and C. G. Collins, New York. In reducing aluminium ores, mixing the comminuted ore with a carboniferous material, sodium chloride, and oxalates, and subjecting the mixture to heat without access of air.

5,472 of 1921 (160,455). Rheinisch-Nassauische Gesellschaft and A. Spieker, Stolberg. For the recovery of zinc from zinc dross or residue, mixing the material with slag and lime, making into briquettes, and treating in a blast-furnace, the briquettes only melting when arriving at the hottest zone of the furnace.

5,851 of 1921 (177,946). W. Graham and D. D. Honeywood, London. Improvements in stamps operated by compressed air, with the object of rotating the stamp shaft and controlling the pressure employed.

6,164 of 1921 (178,264). J. M. Holman and A. T. Holman, Camborne. In air compressors of the reciprocating piston and cylinder type, a cover having in it two concentric annular or segmental ports (serving respectively as inlet and outlet ports), characterized by annular or segmental floating plate valves for controlling the ports, and springs (preferably annular floating springs) for holding the valves normally in their closed positions.

6,618 of 1921 (180,089). Titanium Pigment Co., New York. A titanium pigment consisting of titanium oxide deposited on barium sulphate.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

Geology of the Lower Gila Region, Arizona. By C. P. Ross. Professional paper 129 H, published by the United States Geological Survey.

Production of Gasoline by Cracking Heavier Oils. By E. W. Dean and W. A. Jacobs. Technical paper 258, published by the United States Bureau of Mines.

Automatic Pumping and Notes on Water Analysis and Filtration. By W. Walker Fyfe; edited by J. W. Fyfe. Cloth, small octavo, 110 pages, illustrated. Price 7s. 6d. net. London: Charles Griffin & Co., Ltd.

An Elementary Text-Book on Metallurgy. By A. Humboldt Sexton. Sixth edition, revised and enlarged, by C. O. Bannister. Cloth, small octavo, 310 pages, illustrated. Price 8s. 6d. net. London: Charles Griffin & Co., Ltd.

Cyaniding Gold and Silver Ores. By H. Forbes Julian and Edgar Smart. Third edition, revised and enlarged, by A. W. Allen. Cloth, octavo, 420 pages, illustrated. Price 36s. net.

Eocene Mollusca from Nigeria. By R. Bullen Newton, with an appendix by E. Heron-Allen and A. Earland. Paper boards, quarto, 150 pages, illustrated. Price 17s. 6d. net. Bulletin No. 3 of the Geological Survey of Nigeria.

Coal: Its Properties, Analysis, Classification, Geology, Extraction, Uses, and Distribution. By Ellwood S. Moore. Cloth, octavo, 460 pages, illustrated. Price 25s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Oil and Petroleum Manual, 1922. By Walter R. Skinner. Cloth, octavo, 320 pages. Price 7s. 6d. net. London: Walter R. Skinner, 15, Dowgate Hill, London, E.C. 4. This is the thirteenth annual issue of an indispensable handbook which gives full particulars of all the petroleum and allied companies registered in England or known here.

COMPANY REPORTS

St. John del Rey.—This company has worked the Morro Velho gold mine in Minas Geraes, Brazil, since 1828, and it is 34 years ago since the manager, George Chalmers, took control after a bad cave and evolved the present system of development. The report for the year ended February 28 shows that 167,200 tons of ore was treated, for a yield of gold worth £496,044 at par. Gold from other sources brought an additional £24,000 at par, and silver realized £4,750. The premium on gold represented £121,358, so that the total income was £646,152. The government duties were £15,825 and the working cost £373,103, leaving a working profit of £257,224. Out of this £30,000 has been placed to reserve and £70,000 to capital expenditure account. The dividends were 10% on the £100,000 preference shares, and 10% on £546,265 ordinary shares, together with a bonus of 5% on the ordinary shares. Various factors have combined to make the year the most profitable since the reopening in 1888. The yield per ton was 62s. 9d. at par, the highest recorded, and the low exchange had a marked effect on the working costs. The tonnage crushed was higher than during the previous year or two, but is still below the maximum, 190,000 tons. For some time recently the heat of the bottom workings, combined with offers of railway and other surface work, reduced the labour staff seriously. Conditions have improved during the past year, but the labour position is still far from satisfactory. Developments in depth have been confined to the opening of the 22nd horizon, 6,426 ft. vertically below outcrop, where the ore-body has been proved to be 936 ft. in length. The first of the incline shafts to follow the lode below the level is now being sunk. The ore reserve is calculated at 1,023,600 tons. The installation of air-cooling plant has greatly improved the atmosphere in the lower levels, and Mr. Chalmers gives particulars of the results obtained. As we quote Eric Davies's paper on this subject elsewhere in this issue it is not necessary to deal with the matter here.

Ouro Preto Gold Mines of Brazil.—This company was formed in 1884 by John Taylor & Sons to work the Passagem gold mine in Minas Geraes, Brazil, not far from the mine of the St. John del Rey Co. The ore is of lower grade than that at St. John del Rey. Several reconstructions have been necessary and the dividends have been small. The report for the year 1921 shows that 82,500 tons of ore averaging 7¼ dwt. per ton was treated, for a yield of 26,769 oz. of gold. Including premium, the gold realized £142,456. The working cost was £120,766, and the working profit was £23,490. Out of this, £4,628 was placed to income-tax account, £5,000 was placed to reserve, £6,643 was written off for depreciation, and £8,380 was distributed as dividend, being at the rate of 22½% on the preference shares and 12½% on the ordinary shares. Development has given good results in the lowest levels in all three sections of the mine. In particular there was a notable discovery on the 1,040 metre level, which gives promise of persistence in depth in a south-west direction. A. J. Bensusan, the superintendent, foreshadows further expenditure on plant for work in depth and for increasing the scale of output; also he considers that additional metallurgical plant should be provided for the purpose of increasing the recovery, which is now only about 90%.

Oroville Dredging.—This company was formed in 1909 by F. W. Baker to acquire the share capital of an American company operating gold dredges in California. Subsequently gold-dredging properties were acquired in Colombia, and transferred to subsidiaries, the Pato Mines and Nechi Mines respectively. Also the Colombian Corporation was formed to work the Constancia lode-gold property in the same region. The report for the year ended September 30 last shows that the American company has been liquidated on the exhaustion of the Californian properties, and that the company is now solely a holder of shares in the Colombian companies before-mentioned. Examination of further gold-mining properties, however, is being conducted. During the year dividends were received of £62,996 and £93,616 from the Nechi and Pato companies respectively, and £137,307 was distributed among shareholders, the rate being 20%.——**Pato Mines.**—During the year ended September 30 last gold worth $608,511 was extracted from 555,937 cu. yd. of ground at a profit of £95,455. The yield per yard was 39·1 cents, and it is noteworthy that this is double the figure given by the original prospecting drill.——**Nechi Mines.**—During the year under review gold worth $653,088 was extracted from 2,628,684 cu. yd. of ground, the yield per yard being 24·8 cents. The company's profit was £140,934.

Esperanza.—This company has worked the Esperanza gold mine at El Oro, Mexico, since 1903. Large profits were made for some years, but recently operations have been confined to the treatment of low-grade ore, and old tailings and fillings. The report for 1921 states that 159,445 tons of material was treated, but no particulars are given of the output of metal. The current monthly operations as a whole were profitable, but the writing down of the stores, etc., changed the profit into a deficit. Owing to power shortage the scale of operations was curtailed, and for that reason it was necessary to pick the ore of best quality for treatment. A new metallurgical system is being devised for the low-grade ores. Throughout the year exploration on the Descubridora vein has been continued, and though some of the assay results were high the distribution of the gold was erratic and the ore-shoots very narrow. Prospecting for the continuation of the rich vein found in the adjoining Mexico Mines has not yielded any results so far. Prospecting on both of the above-mentioned lines is to be continued. The main reserves consist of 750,000 tons of low-grade ore and fillings.

Great Boulder Proprietary.—This company has worked one of the great gold mines at Kalgoorlie since 1894, and has paid a continuous succession of handsome dividends. During the last two or three years the tonnage treated has been less, owing partly to poor labour supply and partly to the fact that the lower limits of the ore are defined. Sir George P. Doolette is chairman and Richard Hamilton is manager. The report for 1921 shows that 94,051 long tons of ore averaging 15·08 dwt. per ton was treated. The par value of the gold extracted was £347,547, and £89,529 accrued from premium. The profit was £212,020, out of which £43,876 was allocated to taxation account, £26,960 was written off for depreciation, £10,000 was placed to reserve, and £131,250 was distributed as dividend at the rate of 75%. The ore reserve is estimated at 192,065 tons averaging 14·87 dwt., as compared with 245,187 tons averaging 14·75 dwt. the year before, and 325,314 tons averaging 14·56 dwt. at the end of 1919. The O.K. mine at Norseman is equipped, and stoping was to commence in

February, the ore to be sent to the Great Boulder mill.

Robinson Deep.—This company belongs to the Consolidated Gold Fields group, and works a deep-level property in the central Rand. Operations have never been profitable, and the company is saddled with cumulative preference shares, the dividends on which are in arrears, and with a loan of £300,000 from the parent company and Central Mining. The report for 1921 shows that 695,750 tons of ore was raised and sent to the stamps. The yield of gold by amalagamation was 131,973 oz., and by cyanide 77,743 oz., making a total of 209,716 oz. The revenue from the sale of this gold was £1,101,106, of which about £217,813 represented premium. The working cost was £921,307, and the working profit £179,799. Of this profit, £112,561 was spent on sinking and equipping the new sub-vertical shaft, and £19,500 was paid as interest on loans. The tonnage was considerably higher than the previous year owing to the better supply of native labour, and the cost per ton was reduced from 29s. 2d. to 26s. 6d. The ore reserve is estimated at 1,936,000 tons averaging 6·7 dwt., as compared with 1,597,000 tons averaging 6·97 dwt. the year before. In the present estimate the mimimum content is taken at 5 dwt. as against 5·5 dwt. last year.

Planet-Arcturus Gold Mines.—This company belongs to the Gold Fields Rhodesian Development group, and owns the Planet, Arcturus, Slate, and other properties. Early operations we e not successful. Later, in 1918, the Slate and Arcturus were leased to the parent company, which advanced working capital on mortgage. Milling was recommenced in June, 1920, after due development had been done. The report for 1921 shows that 65,120 tons of ore was treated, yielding 29,911 oz. of gold, which sold for £157,334, including premium. The working cost was £112,681 and £33,918 was spent on development and stores. The balance, £10,734, has been applied towards the reduction of the parent company's loan. Development has made no appreciable addition to the reserve of ore. Owing to the disappointing results the parent company determined to work the best ore and close down. It has been found, however, difficult to pick out the best ore owing to the erratic distribution of the gold, and it has not been possible to pursue this policy in its entirety. The reserve is calculated at 98,920 tons averaging 13·3 dwt., together with 52,170 tons averaging 7·9 dwt.

Prestea Block A.—This company was formed in 1903 by Edmund Davis to acquire gold-mining properties from the Prestea and Appantoo companies. Additional property was subsequently acquired from the Appantoo, and in 1911 the property of the Prestea company was absorbed. Milling commenced in 1906, but was suspended from 1909 to 1911, pending further development. The ore is troublesome owing to the graphitic content. The capital has been increased and rearranged on several occasions, and another scheme of reconstruction is now in hand. The report for 1921 shows that 87,053 tons of ore was treated for a yield of gold worth £152,329. Together with premium this gold realized £189,800. The working cost, including development redemption, was £268,080, and £20,561 was written off for depreciation. The loss for the year was therefore £98,841. The ore reserve is estimated at 120,481 tons averaging 42s. 2d. per ton, presumably at par. S. H. Ford, one of the directors, reports that developments in the bottom levels are hopeful. The scheme for reconstruction provides for £50,000 additional working capital. Particulars of this scheme are given under Review of Mining.

Tronoh Mines.—This company has worked alluvial tin properties in Perak, Federated Malay States, since 1901, and in the early days earned large profits from the treatment of high-grade ground. At the present time dredges are working the poorer ground, and other sections are let on tribute. C. V. Thomas is chairman and J. H. Rich is general manager. The report for 1921 shows that No. 2 dredge was in operation throughout the year, extracting 263 tons of tin concentrate from 817,223 cu. yd. of ground. No. 1 dredge was not operating, as necessary repairs had not been effected. No. 3 dredge started work in October and extracted 25 tons up to the end of the year. Tributors won 903 tons, bringing the total output of the mines during the year to 1,192 tons. The chief tributor was Chung Thye Phin, who extracted 497 tons by means of gravel pumps. The sale of the concentrate brought £122,654, and there was a profit of £4,779. During the year blocks of land were purchased from Tronoh South for £6,000.

Tronoh South.—This subsidiary of the Tronoh now works the Pari alluvial tin property. During 1921, the output was 80 tons of tin concentrate, selling for £7,213. The balance of profit was £2,357, which extinguished the loss of the previous year.

Lahat Mines.—This company belongs to the Tronoh group, and has operated alluvial tin properties in Perak, Federated Malay States, since 1906. Osborne and Chappel are the general managers. The report for 1921 shows that 637 tons of tin concentrate was sold, as compared with 533 tons the year before. Owing to the fall in the price of tin, the profit for the year was only £125.

South Bukeru (Nigeria) Tin.—This company was formed by the late S. R. Bastard in 1910 to acquire alluvial tin properties on the Bauchi Plateau, Northern Nigeria. The report for the eighteen months ended December 31 last shows a total output of 229 tons of tin concentrate, and an adverse balance of £5,160. Owing to losses incurred the company let the properties on tribute on March 1, 1921, and since then the financial position has been more satisfactory.

Ex-Lands Nigeria.—This company was formed in 1912 to acquire from the Exploring Lands and Minerals Co. alluvial tin properties in the South Bukeru district, Bauchi Plateau, Nigeria. Dividends were paid for the years from 1915 to 1920. The report for the year 1921 shows that the output of tin concentrate was 307 tons, as compared with 382 tons in 1920. The revenue was £24,595, and the working profit was £1,217, and in addition there was a credit of £5,450 for Excess Profits Duty refunded. The balance was carried forward.

Ropp Tin.—This company was formed in 1911 to acquire alluvial tin properties in the southern part of the Bauchi tin district, Northern Nigeria. Edmund Davis is chairman and the engineering management is with the Consolidated Gold Fields. Tin concentrate is won by sluicing, calabashing, and dredging, two dredges with buckets of 2¾ cu. ft. capacity being erected in 1917 and 1918 respectively. The report for 1921 shows that the total output of tin concentrate was 1,367 tons, the credits £114,715, and the net profit £17,021. The shareholders received £16,800, or 10% less income tax. The proved ground in reserve is estimated to contain 8,785 tons of cassiterite.

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EDITORIAL

MUCH experimenting has been done recently in Australia and America with a view to devising methods of treating oxidized copper ores that avoid the necessity for erecting costly electrolytic works. Particulars of some of these processes have already been given in these pages, and in future issues further information will be published. In the current issue there is an article on the Nevill-Soanes process. This process has not yet got much beyond the laboratory stage, but the proposed reactions are interesting and consideration of the inventors' suggestions are warranted. To Mr. Nevill's article are appended discussions of the process by competent Australian authorities, who examine the advantages and the possible disadvantages of the process.

THE progress made by the mining and metallurgical department of the Sir John Cass Technical Institute, Jewry Street, Aldgate, is gratifying to all interested in technical education. Under the guidance of Mr. George Patchin, head of this department, the scope and range of studies have continuously expanded. The latest step is the establishment of a three-year course on Metallurgy for Engineers, covering heat-treatment of metals, metallography, mechanical testing, foundry practice, and analysis of engineering works material. It will be remembered that at this Institute the instruction is given in the evening, and opportunity is thus afforded those engaged in business or other occupations during the day to undertake studies that will help them in their careers. The Institute occupies a distinctive place in the City's scheme of education.

PROPOSALS to make St. Just in Roseland, on the east side of Falmouth Harbour, a port of call for Transatlantic steamers have once more been brought forward. In the old days Falmouth was a recognized port for passenger sailing ships and steamers, but the Cornish railways were never equal to the demands of more modern heavy traffic, and Southampton and Liverpool, and to a smaller extent Plymouth, gradually absorbed the business. It is probable that even Plymouth is seriously handicapped by the severe haulage problems between that port and Exeter, so that Falmouth or St. Just would be even more at a disadvantage. The Cornish lines have been greatly improved of recent years by the substitution of stone viaducts for Brunel's timber bridges, and probably everything has now been done to put the tracks in the most favourable condition for use in connexion with Transatlantic and other services of steamers. A line from St. Just would have to be built, up the Fal valley to Grampound Road or St. Austell, in addition to an extensive quay. As for the convenience of the harbour from a maritime point of view, this is already well known and requires no reference here. Any scheme that promises to be of commercial assistance to Cornwall will be welcomed by mining men, and it is therefore to be hoped that the railway difficulties have been overcome.

REGISTRY of a company under Guernsey or Isle of Man laws is not a proceeding favoured by financiers. It is true that such a proceeding used to have the advantage of saving capital, owing to the low registration fees imposed by those islands, but responsible people have always held that such registrations savour of attempts to put difficulties in the way of shareholders and creditors who may be seeking for information relative to the companies in question. Last month Mr. Justice Astbury, in the Court of Chancery, expressed himself in no measured terms on this subject, stating that such registrations were sometimes mere tricks to make easy the commission of frauds, and that he had personally known a good many swindles of this character. He therefore refused permission for a certain company whose affairs were before him on this occasion to register in Guernsey in the course of its reorganization. We take this opportunity of quoting an official judicial opinion to the effect that a Guernsey or Isle of Man registration on the part of an English company is to be looked at askance.

THE political future of Rhodesia has been a vexed topic of discussion for some years. It is clear that a decision must be made before 1924, when the charter of the British South Africa Company expires, otherwise the territory will relapse to the undesirable status of a Crown Colony. The obvious solution of the matter would be the absorption of Rhodesia in the Union of South Africa, but the residents have hitherto been

disposed to favour the formation of a self-governing dominion. Seeing that the white population of Rhodesia is very restricted, being probably less than 20,000, the proposal for a self-governing dominion seems to the onlooker to be far too ambitious. Such a dominion in the middle of a continent and cut off from the sea would be overwhelmed by financial and transport questions, and the responsibility of its leaders would be crushing. It is with no small relief, therefore, that the friends of Rhodesia will read the terms for incorporation in the Union offered by General Smuts. Probably, also, the confidence in this great statesman evinced by many Rhodesians after his sweeping victory at the polls last year will be vastly expanded by his masterly treatment of the Rhodesian question and popular sentiment may veer round to his side. It is not necessary for us to discuss the general details of the proposal, for these are dealt with adequately in the financial and political press. There is, however, one point to which attention may be drawn here. General Smuts says that the Rhodesian mining law will continue in force after incorporation in the Union. It seems a pity to perpetuate this American-based law, which has caused so much trouble with regard to ownership. Americans themselves are heartily tired of the unworkable principle embodied in this law. We therefore suggest that Rhodesia should be unburdened of the incubus when it joins the Union.

The Indian Gold Output

Readers who follow the MAGAZINE'S statistical pages will notice that the table relating to the outputs of the Indian gold mines has been rearranged and fuller details are given as regards the source of the gold extracted. Hitherto the table gave merely the tonnage of ore sent to the stamps and the total gold output. Seeing that nowadays an important proportion of the gold comes from the re-treatment of old tailings, the figures on the table were incomplete, and have led to many misconceptions as to the nature and results of the metallurgical processes. The companies themselves have always published fairly complete information and they are not responsible for any misconceptions that have arisen. In order to place the monthly returns in their true perspective, a brief review of the actual operations may be here given.

The ore at the mines in the Kolar district are eminently free-milling. They have always responded satisfactorily to amalgamation, and a 90% recovery can be easily obtained by this process. The companies, therefore, were in no hurry to adopt the cyanide process, doubting whether the gold extracted would pay the cost of treatment. Gradually, however, cyanide plants for sand and slime were introduced, together with re-grinding plant, though even now most of the gold in the tube-mill sand is caught on amalgamating plates below. At first only current tailing was treated, but more recently the great dumps of tailing from earlier operations have been tackled. As the ore treated twenty and thirty years ago was richer than that which is now being raised, it follows that the old tailing is of rather higher grade than that which is produced nowadays. The present position is admirably indicated in the report of the Champion Reef company for the three months January to March of this year. During this period 34,493 tons of ore was sent to the stamps, where 9,451 oz. of gold was extracted by amalgamation; 18,440 tons of coarse current tailing was re-ground in tube-mills, and from this material 2,450 oz. was extracted by amalgamation plates below; 35,079 tons of current tailing was sent to the cyanide plant, where 1,920 oz. was extracted. The ore fed to the stamps averaged 8·15 dwt. gold per ton; the yield by amalgamation was 6·9 dwt. per ton, and by cyaniding 1·1 dwt., making a total of 8 dwt. per ton; the recovery was just under 97%, of which 84% was accounted for by amalagamation and 13% by cyaniding. It will be seen, therefore, that, though there is not now so much need for care in amalgamation as was the case when there was no subsequent process to catch escaping gold, by far the largest proportion of the gold won came from the amalgamation plates. As regards the treatment of old tailing, the plant was only in course of erection during the three months under review, but 14,946 oz. was cyanided for an extraction of 888 oz. of gold, being a yield of 1·2 dwt. per ton. During June the amount of old tailing treated had increased, being about 11,000 tons, as compared with 14,946 tons already quoted for the three months January to March.

The influence of the old tailing on the gold returns can be more conveniently demonstrated by reference to the report of the Mysore company for the year 1921. Here we find that 202,289 tons of ore was sent to the stamps, where 84,703 oz. of gold was

extracted, while 521,229 tons of current and old tailing was cyanided for a yield of 45,321 oz. The yield of gold per ton of ore milled was 8·4 dwt., and of tailing 1·7 dwt., figures which indicate that the old tailing is of rather higher grade than the current tailing. The relative proportion of gold extracted by amalgamation and cyaniding is much the same as with Champion Reef, and the actual figures need not be quoted. The chief reason for quoting the case of Mysore is to show how a wrong inference may be drawn from the figures if due care is not exercised. For instance, if the tonnage of ore crushed and the returns of gold are taken, the mistake may easily be made of supposing that 130,024 oz. of gold was extracted from 202,289 tons of ore, giving a false return of 12·8 dwt. per ton instead of 9·7 dwt. Also if 84,703 oz. is taken as the yield by amalgamation and 45,321 oz. as the yield by cyaniding, all drawn from ore milled, it can be made to appear that 65% of the gold is won by amalgamation and 35% by cyaniding. These are two instances of misapprehensions which are prevalent, and it is with the object of giving the true interpretation of the figures that this article is written. Incidentally, however, it may be mentioned that these old dumps are providing an increasingly important source of income for the Mysore company and others of the same group, which is likely to prove very welcome to shareholders in the critical days of exploration at depth through which these mines are passing at present.

Knowledge of the Overseas Dominions

The Premiers of South Australia and West Australia, on their arrival home after a visit to the old country, have expressed their wonder, almost resentful wonder, at the ignorance displayed by the average Englishman on all matters relating to Australia. This dictum draws attention once more to the anomalous fact that, though Britain is a maritime kingdom whose naval and commercial influence has spread to every quarter of the earth, the majority of the inhabitants of these islands have a distinctly limited knowledge of anything outside their boundaries. Politicians, particularly, often exhibit a ludicrous ignorance of the Colonies and Dominions, and no doubt the Premiers of the two Australian States mixed largely with this section of society during their visit here and so obtained an exceptionally bad impression. In commercial circles also there is a surprising absence of general knowledge of other countries, unless the individual or the company is in direct contact with some particular business abroad. For instance, the average dealer in cloth and the average wearer of clothes may be quite ignorant of the fact that most of our wool comes from Australia, though the buyers and weavers are fully aware of this circumstance. On the other hand, the Bradford cloth producers probably do not know that the bulk of the gold wherewith our bankers bolster up American exchange comes from the Transvaal mines; as likely as not the word "Rand" is not in their vocabulary. A knowledge of commercial and political geography is derived from special study, opportunities for which are not provided by our ordinary avocations.

The foregoing remarks may possibly be mistaken for platitudes; but they serve actually as a peg for a criticism of the Overseas Governments with regard to the facilities given by them for the distribution of information by their London representatives. The expostulations of the two Premiers provide the opportunity of pointing out one of the contributing reasons for this ignorance prevalent in England. To put it bluntly in the form of a *tu quoque* retort, many of the official representatives of the Overseas Dominions do not appear to know much more about their respective countries than the Englishman. It is proverbial that the Agent-General is about the last man to be able to give an answer to a specific inquiry relating to his country. That this should be so is not necessarily his own fault, but more often can be blamed on his authorities at home who fail to keep him posted in connexion with new departures and new enterprises. As an instance we may mention that inquirers at the London office of one of the Australian States for a recent publication relative to one of the great ore-fields of Australia are informed that this cannot be supplied in London; no copies have been received and none are expected; that publications of this character are only obtainable by direct application to the State printer somewhere in Australia. Again, an inquiry was made at another Agent-General's office as to the progress of construction of a certain railway and of the Government's policy in connexion with prolongation toward a promising mining district, but no one in the office had any knowledge whatever of the matter.

It must not be supposed that our criticism applies to all Overseas Governments, for there are notable exceptions, of which the Indian and Ontario Governments deserve special mention. Readers of the MAGAZINE must be aware that these two Governments liberally distribute information about their countries. Three years ago the Indian Government created a Trade Commission in Winchester House, and Mr. D. T. Chadwick, the Commissioner, has done excellent work in advertising the resources of the Dependency. As he has been assisted by two mining geologists, Messrs. Coggin Brown and Cyril Fox, his advice relating to mineral deposits was of very great value. His successor, Mr. Lindsay, is due to arrive from India shortly, and he will no doubt continue the good work. As regards the Ontario Government's propaganda, Mr. Noxon, the Agent-General in London, is doing much to draw attention to the mineral resources of that province. He has addressed members of the Mining and Metallurgical Club on the subject, and mining men are assured that he will help them whenever opportunity arises. The Federated Malay States has an effective office in London for distributing information. These three instances indicate that a knowledge of Overseas Dominions can be imparted to Englishmen by the Dominion Governments, and that the two Premiers beforementioned may themselves easily aid in removing the ignorance of which they complain. If we may say so without offence, probably a little less inclination to aloofness and a little less of the flavour of antagonism to the old country might improve the average Englishman's knowledge of, and interest in, Australia.

China-Clay and Soap

In the MAGAZINE for April, 1920, reference was made, when writing of the prospects of Tehidy Minerals, Ltd., to the possible outlet for china-clay in the manufacture of soap. A chemist, Mr. F. G. Weston, had announced that colloidal clay, that is, the fine clay which will not mechanically settle from water, could be used for making soap, and that the soap thus produced is an excellent frother and remover of grease and dirt. As details were lacking, no opinion could be given at the time. The wording of Mr. Weston's statement was so vague that any ordinary observer would naturally read into it the suggestion of a saponification of colloidal clay, which is obviously absurd. A further announcement has been made by this chemist, which puts the matter in its true light. Before quoting him in detail his evidence may be briefly summarized by saying that colloidal china-clay is used as an adulterant of soap, but that at the same time it is alleged to be a useful one. A soap chemist could write a humorous article on imitations and adulterations, and on the efforts to make a multitude of cheap things look as much as possible like soap, but this phase of the matter may be dismissed here by saying that china-clay is not an objectionable constituent in soap and that its use as an adulterant is more or less venial.

Mr. Weston states that when colloidal china-clay is added it makes a material better in several ways than pure soap. The clay lowers the surface tension of the soap solution. It gives greater adsorptive power, increased lathering properties, and a greater detergent power due to better emulsifying action. He also says that, if the clay is added during the manufacture of the soap, the time required for saponification is reduced, with a saving in cost of production. The soap containing clay is declared to be more soluble in water; it is stated to be ready for use sooner after manufacture, as it dries quicker, though not becoming too dry by long keeping; it is believed to be less likely to contain free fatty acids or free alkali; and it improves in quality on ageing.

Thus it appears that, though china-clay is just a "filler" for soap, the chemists can show that it performs a useful service. We may wonder why the word "colloidal" need be employed at all, and we may guess that its use is solely for the purposes of mystification. To say that china-clay is mixed with soap would betray a hard fact, but the introduction of a modern scientific term of subtle significance adds the soothing suggestion of romance. Thus the wording at the beginning of this article may be altered so as to omit reference to clay which will not settle from water; so we come to the prosaic fact that the ordinary china-clay of commerce has been used by soap-makers for long enough, and that only recently has it been deemed advisable to give a scientific or pseudo-scientific explanation. So far from our objecting to the use of china-clay in this way, we would even encourage it, hoping thereby to help in some small degree to improve the lot of the Cornish china-clay worker.

REVIEW OF MINING

Introduction.—There is not much increase in activity in engineering circles in this country or in mining inquiries in London, but there is a general feeling of hopefulness with regard to the future. In the metal market the advance in the price of tin is not believed to be due to increased consumptive demand, but to a market operation; as those responsible for this movement are good judges of business affairs it is comforting to believe that it is a case of intelligent anticipation. The prolongation of the coal strike in the United States has led to inquiries for coal from this side, and a slight fillip has thereby been given to the production at some of the British coalfields. The war debts of the Allies and ex-enemies still cause anxiety in financial and political circles.

Transvaal.—Our South African correspondent writes cheerfully of the efforts made to reduce costs, and gives specific examples of movements in this direction. The output and the supply of native labour are approaching the level of the last few years, but the mines could still absorb many more natives if they were available. The improved position of several of the low-grade mines is reflected in the rise in the market quotations of their shares.

In the report for 1921 of the Transvaal Gold Mining Estates, quoted elsewhere in this issue, it was stated that prospecting and development at the Elandsdrift mine were giving only indifferent results. It has since been announced that high-grade ore has been exposed on the fourth level, and that further investigation is being made as rapidly as the water and difficult ground will permit.

Until recently the developments at West Springs have not been altogether satisfactory, as has already been recorded on several occasions in this column, but the chairman of the Anglo-American Corporation, in his speech to shareholders in June, gave rather a more hopeful report of the results of recent work. Still later it has been reported that large bodies of high-grade ore are now being disclosed, and that the provision of a treatment plant may be considered before long.

Rhodesia.—The output of gold during June was 55,614 oz., as compared with 53,920 oz. in May and 49,466 oz. in June, 1921. Other returns from Southern Rhodesia were: Silver, 14,745 oz.; coal, 39,613 tons; chrome ore, 300 tons; copper, 291 tons; asbestos, 1,069 tons; arsenic, 24 tons; mica, 6 tons; diamonds, 16 carats.

The Globe and Phœnix reports the ore reserves on June 30 at 105,500 tons, averaging 25·6 dwt. gold per ton, as compared with 110,000 tons averaging 25·5 dwt. on December 31 last. The monthly tonnage treated recently has been about 6,000 tons, averaging rather less than an ounce, so no doubt development ore of lower grade and ore not provided for in the estimate have been milled in order to conserve resources.

The Rhodesia Broken Hill is now producing vanadium ore on a commercial scale. There is on hand about 7,500 tons of ore varying from 4 to 15% of vanadium oxide, and the indications are that further large amounts will be developed. A contract has been made to ship 20 tons per month for three years, and an additional contract is in process of negotiation. The silver content of the lead ore has increased recently, and now averages 9½ oz. per ton. The refiners who treat the lead produced at the mine are agreeing to pay for anything over 5 oz.

As recorded last January, the Bwana M'Kubwa Copper Mining Co. has been reconstructed with the object of introducing new capital by Mr. Chester Beatty's group. Mr. P. K. Horner, who used to be manager for the Union Minière farther north, was appointed manager early this year, and he has already made an examination and submitted a cabled report. He states that it will be cheapest to mine to the 250 ft. level by open-cut, and that with a suitable steam-shovel outfit, having a capacity of 1,000 tons per day, the cost of mining should not be more than 3s. 6d. per ton. The amount of ore that can be treated in this way is estimated at 3,000,000 tons, averaging 3·6% copper. Below the 250 ft. level and to the 500 ft. level the amount of ore is estimated at 2,500,000 tons, averaging 3·8%. Exploration at depth by means of the diamond-drill is being undertaken. Minerals Separation has acquired a financial interest in the reconstructed company, and the metallurgical process invented by Mr. W. G. Perkins, and controlled by that company, is to be applied.

West Africa.—Like most mines in this part of the world, Abbontiakoon is suffering from a scarcity of labour. The monthly output of ore is only 7,000 tons, though the capacity of the treatment plant is 13,000 tons and the developments warrant a greater

extraction of ore. It is proposed to sink a new shaft to tap the ore at the northern end, and so eliminate a 3,000 ft. haulage by native labour.

Nigeria. — Negotiations between the Nigerian Chamber of Mines and the Liverpool smelters have resulted in the further reduction of the returning charge from £10 to £8. Last December we recorded that the charge had been reduced from £14 to £10. The charge immediately before the war was £6 5s.

At the meeting of the Niger Company held last month, Lord Leverhulme was able to assure shareholders that things had got to their worst and that depreciation of stock had been fully provided for in the accounts. An improvement in business conditions is now confidently anticipated.

Australia. — Considerable interest has been aroused in this country by the statement made by Mr. W. H. Woodhead, chairman of the British Broken Hill Company, with regard to the contract between that company and the Broken Hill Associated Smelters for the smelting of the company's ores and the disposal of the products. Before the war the company, like many other Australian mining companies, sold its concentrates to Germany. These shipments were suspended by the war, and in 1916 the British Government cancelled enemy contracts, thus permitting the companies to resume production for the benefit of the Empire. Shortly afterwards the Commonwealth Government placed an embargo on the export of ores, and indicated that these would have to be smelted in Australia. The company had no alternative but to send its ores to the Associated Smelters at Port Pirie. It subscribed capital to the Smelters Company, but did not obtain representation on the board, though another outsider, the Zinc Corporation, was able to do so. The contract with the Smelters was distinctly one-sided, for it provided that the Smelters could treat the British Broken Hill ores whenever it liked, and dispose of the products with a similar wide choice of time and opportunity. Thus the British company never knows how it stands financially, for the Smelters company can report results according to its own convenience. Comment on this anomalous position is inadvisable at present, for the company is commencing an action in the Australian Courts for a rescission or modification of this contract, arguing that such a contract, though well enough in war time, is not only out of place nowadays, but unconscionably oppressive.

The position at the Hampden Cloncurry company's copper mines is becoming increasingly serious. Not only is there no prospect of a restart of smelting owing to continued high costs, but it has become necessary to suspend all underground work, and put the properties on a care-taking basis. Also pumping has been suspended at most of the mines, and the water is rising. In order to further economize, many of the outlying properties have been abandoned and their leases allowed to lapse.

A brief cabled report of the Mount Morgan company for the year ended May 31 has been received. The mine and smelter were idle from April 17, 1921, to March 13, 1922. After resumption at the latter date to the end of the company's financial year, operations were restricted owing to the difficulty in obtaining skilled machine miners. The output of ore has in consequence been below normal, so that, in spite of the cut in wages ordered by the Court, losses are still being made. Every effort is naturally being made to secure a full underground staff. The amount of ore raised during the period under review was 50,528 tons; the smelter treated 16,419 tons of ore and 10,518 tons of concentrate, for a yield of 1,074 tons of copper and 12,492 oz. of gold.

The full figures for the output of zinc from the beginning of operations at the Risdon works of the Electrolytic Zinc Co. of Australasia have come to hand this month. In addition to the zinc, the following table gives the lead and silver contents of the residues sent back to Port Pirie for smelting:

Period ended	Zinc Tons	Contents of products sent to Smelters. Lead Tons	Silver Ounces
December 14, 1921	[illegible]	91	15,693
January 11, 1922	1,238	155	31,407
February 8, 1922	[illegible]	222	36,277
March 8, 1922	1,457	183	39,896
April 5, 1922	1,581	189	39,348
May 3, 1922	[illegible]	197	36,736
May 31, 1922	1,825	210	38,724
June 28, 1922	1,981	245	46,875

Malaya.—The output of gold in the Federated Malay States during 1921 is reported at 14,674 oz., of which 14,430 oz. came from the Raub mine in Pahang.

As reported recently the Ipoh Tin Dredging Co. found it impossible to finance the completion of the purchase of the two new dredges ordered, and sold one of them, together with the land to be worked by it, to the Kamunting company. This sale resulted in a loss to the company of £29,356. The company also

made a loss of £11,910 on the operations during the year ended March 31, making the total adverse balance £41,266. It is proposed to write down the capital of the company by this amount, by reducing the par value of the 200,000 shares from £1 to 16s., in order to remove the loss from the books of the company.

The Renong Tin Dredging Co., whose doings may now be recorded under the heading of Malaya, owing to the new properties being in Selangor, has been the victim of two accidents. Dredge No. 2, operating at the Selangor property, has been sunk, and a similar misfortune happened in April to dredge No. 3, which is still at the old Siam property. No. 3 has since been floated again, and should by now have recommenced operations.

Cornwall.—When recording last May that South Crofty was receiving Government guarantee for a loan, we mentioned that the case of Levant was also being considered. It has now been announced that, on the advice of the Trade Facilities Act Advisory Committee, the Treasury has agreed to guarantee a loan of £10,000 to be raised by the Levant Company. Brief note of the new work inaugurated by Col. Freethy Oats, the chairman of the company, was made in our March issue.

Norfolk.—Periodically there are signs of restiveness on the part of shareholders at the absence of information relating to operations at the oil-shale workings of the English Oilfields, Ltd. Last month this dissatisfaction was evidenced by the usual crop of letters of inquiry in the financial papers. These drew the customary reply couched in more or less vague terms. On this occasion it is candidly admitted that the distilling problem is causing difficulty, as also is the problem of reducing the sulphur content. Thus the company recognizes the present status of the technology of oil-shales.

Canada.—In April we recorded that the Bingo Gold Mines, a property at Herb Lake, Manitoba, had been brought to the notice of investors in London. At the time the property did not appeal to investors, owing to the big purchase price required by the promoters. We are now informed that sufficient support was eventually received to warrant the formation of the company in London, and that shares have been allotted, the exact amount of which, however, is not stated.

Much was expected by those interested in Northern Manitoba of the Murray gold properties at Elbow Lake, on which the Hollinger company had an option. It is distinctly disappointing, therefore, to hear that this option has been abandoned, owing to the rich occurrences of gold proving to be patchy and not persistent in depth.

News is to hand that a further discovery has been made in the Flin-Flon district, Manitoba, where the Mining Corporation of Canada recently acquired the well-known copper property named after the district. The new discovery has been made at Cliff Lake, on a property owned by Mr. J. H. Curzon. Stripping and trenching have revealed a copper-bearing pyritic ore-body 200 ft. in width.

Mexico.—Much has been heard recently, mostly in the form of scare news, of the threat of salt water in Mexican oil-wells. A definite statement on the subject comes from the Mexican Eagle Company, to the effect that salt water has appeared in San Geronimo Well No. 2. Other wells in this district are being drilled, and oil has already been met with in a higher part of the geological structure.

The directors of the Mazapil Copper Company have informed their shareholders that negotiations are in hand for the sale of the properties. The company is controlled in Manchester, and owns copper and lead mines in the State of Zacatecas. Satisfactory dividends were paid before the Mexican revolution, and also for 1919, but the recent depression in metals has given the company a setback.

Bolivia.—The report for 1921 of the Compagnie Aramayo de Mines en Bolivie shows a profit of 1,847,844 francs, as compared with 5,279,967 francs the year before. Dividends totalling 10% were paid for the year. It is stated that the sales of tin concentrate brought no profit, but that silver ore was sold to advantage. The production of tin concentrate during the year was 2,361 tons, and of copper in precipitate 93 tons. The silver in the ore produced was 1,178,215 oz. For the first time the company gives statistics relating to the production of bismuth, which is reported at 29,431 kilogrammes, but it is stated that the demand was poor and the price low. Of all the mines of this company the Chocaya is giving the best results of development, the ore averaging 7% tin and 50 oz. silver per ton.

THE NEVILL-SOANES COPPER PROCESS

By P. W. NEVILL

With addenda by A. MONTGOMERY, State Mining Engineer for West Australia, and F. C. STOCKWELL, Assistant Director of Technical Education for West Australia

THE PROCESS.—The process here described consists of treating finely crushed copper ore with sulphuric acid or ferrous sulphate to dissolve the copper oxide or carbonate, and precipitating the copper as metal by introducing finely divided metallic iron into the ore pulp and agitating while hot, without any filtering; the precipitated copper may be recovered by elutriation or by flotation.

The old hydrometallurgical processes have comprised at least the following steps: (1) Treatment of the ore with a solvent; (2) filtration to separate the copper-bearing solution; (3) precipitation to throw down cement copper. These steps involve stages which are slow and require the use of a strong corrosive solution, and if sulphuric acid is the solvent employed, about $2\frac{1}{2}$ lb. of acid is required for every lb. of copper recovered. The highly dangerous nature of this acid precludes its economical transport, and consequently its use has been successful only where acid works have been erected at the point of treatment, at a very heavy capital outlay. The precipitation has usually been effected by scrap iron, and under the most favourable circumstances a consumption of one pound of iron for one pound of copper represents the maximum precipitation ratio.

The new process comprises only two steps: (1) A decomposition of the copper compounds in the ore and precipitation of metallic copper in the ore pulp; (2) separation of cement copper from such pulp. The first step requires the presence of a small proportion of a salt or an acid, and, as the reaction is a regenerative one, one part of copper can be decomposed with a consumption of one-fiftieth part of sulphuric acid, thereby resulting in an enormous economy over the old method.

Further important features in this part of the process are that as the solutions used are extremely dilute, corrosive influence on the plant is inappreciable; and by virtue of the comparative rapidity of the reaction a relatively small capital outlay provides a plant having a large output. The precipitating medium, as in the old process, is metallic iron, but there is an important advantage associated with its use in the new process, namely, that while the best result that can be achieved with the old methods is one part of copper to one part of iron, this is really the least favourable result that has been obtained by the new process. It has been found that with some ores as high as two parts of copper can be precipitated by one part of iron, thereby permitting an important economy.

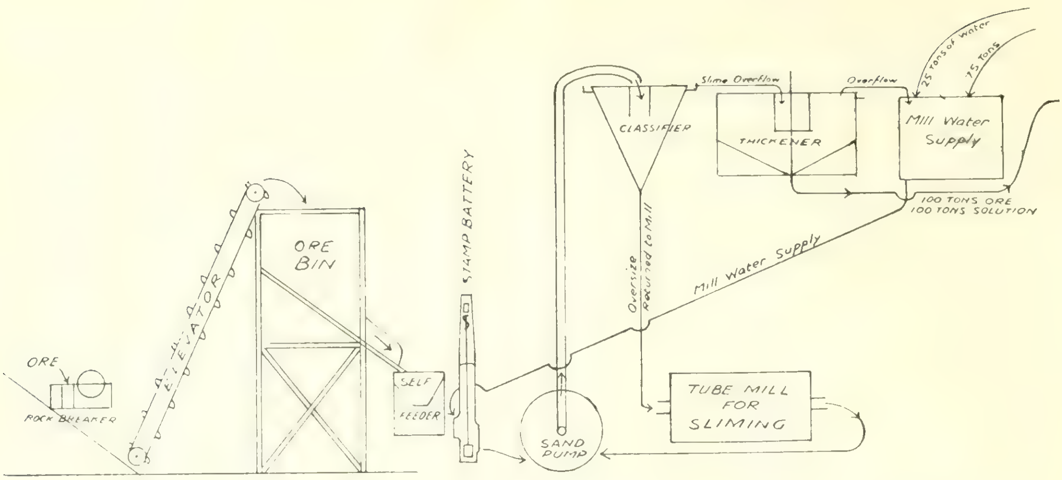
The final step in the process, namely, the separation of the cement copper from the pulp will, in practice, not involve any difficulty, for the reason that either of two realiable methods may be employed: (1) Elutriation, or washing of the slime, if all the ore was previously crushed to a very fine state of division; (2) flotation.

EXAMPLES OF TREATMENT.—The process will readily be understood by means of the following examples:—

(1) A sample of oxidized ore containing alkali earth carbonates from the Wandoo mine, West Australia, containing 11·9% of copper, was crushed so that about 90% passed through a 150 mesh screen. To 100 parts of such ore were added 100 parts of water, 2 parts of ferrous sulphate ($FeSO_4$ $7H_2O$), $\frac{1}{2}$ part of common salt ($NaCl$), and 11·5 parts of finely divided iron. After passing steam through the mass for 15 minutes, the oxidized copper contents were substantially converted into cement copper, which it was difficult to separate from the slime by elutriation. On the addition of a little sulphuric acid, however, the cement copper floated, and a recovery of 90% of the copper contents of the ore was effected.

(2) A sample of ore from the Yannery Hills mine, West Australia, containing 19·7% of copper was crushed so that about 85% passed through a 150 mesh screen. To 100 parts of such ore were added 100 parts of water, 5 parts of ferrous sulphate ($FeSO_4$ $7H_2O$), 1 part of common salt ($NaCl$), and 10 parts of finely divided iron. Through the mixture so formed steam was passed for 15 minutes. The slime was separated by elutriation, and a cement copper concentrate remained containing 91% of the copper contents of the ore.

It will be noticed that in these examples ferrous sulphate and common salt were used. These substances can be procured at a cheap rate, and, being readily transported, will, in most localities, be preferable



SUGGESTED FLOW-SHEET FOR NEVILL-SOANES PROCESS AS

to a corrosive substance such as sulphuric acid.

To establish that these results can be equalled when working on a larger scale a Pachuca vat, or Brown agitator, was built, holding 2 cwt. of ore, and certain subsidiary elutriation vessels were also provided to enable a complete test along these lines to be made. It was found that parallel conditions applied, and that an extraction as high as 92% of the available copper contents was obtained.

PROPOSED PLANT.—Considerable practical work has been done and apparatus tried, and the deductions that have been arrived at as to the most suitable plant for general use are given herewith. For the treatment of an oxidized copper ore, the accompanying flow-sheet has been designed for 100 tons per day. This is self-explanatory.

SCOPE OF THE PROCESS. — While the immediate field for this process will be in the treatment of the large quantities of low-grade oxidized ores that abound in various parts of the world, its scope extends beyond these limits, and with preliminary treatment any ore of copper can be dealt with. For example, a sulphide ore, if roasted so as to convert the copper into the oxidized condition, can subsequently be treated in the manner described, and, furthermore, if the roasting has been judiciously conducted, a certain proportion of the copper will be in the sulphated condition, and will therefore supply the reagent required in the process.

THE REACTIONS.—Although acid is mentioned, it is a non-essential in this process, excepting in special cases. The best procedure is to have a working solution, or mother liquor, of ferrous sulphate, or in some cases ferrous chloride, which gives a precipitate of better physical properties, allowing an easy recovery. However, when using ferrous sulphate, the addition of a soluble chloride, sodium or magnesium, is a decided advantage. It may also be found necessary in some ores to have a little free acid present to give a start to the reaction.

The following equation will suggest an explanation of the reaction, when sulphuric acid and iron are the agents employed :—

$$H_2SO_4+7CuO+5Fe = 7Cu+FeSO_4+2Fe_2O_3+H_2O.$$

This shows a conversion of the sulphuric acid to ferrous sulphate, and the reduction of 7 parts of copper to 5 parts of iron, or 441 parts by weight of copper to 280 parts by weight of iron.

When ferrous sulphate is employed the following equation may be expressed, and tests can be made in support :—

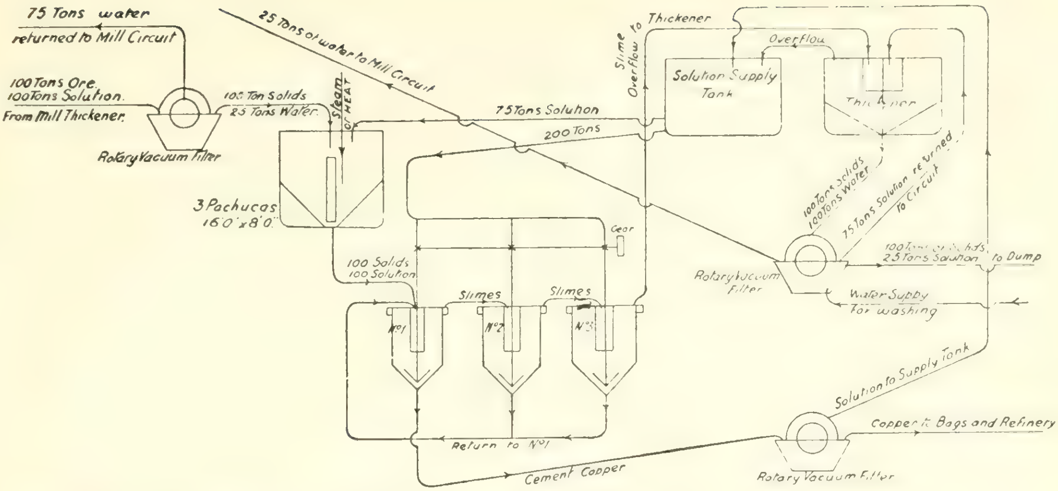
$$FeSO_4+3CuO+2Fe = 3Cu+FeSO_4+Fe_2O_3$$

This reaction shows a reduction of 3 parts of copper to 2 parts of iron, or 189 parts by weight of copper to 112 parts by weight of iron, and the ferrous sulphate remaining constant.

If cuprite is present, it would be reduced according to the first equation as follows :—

$$H_2SO_4+7Cu_2O+2Fe = 14Cu+FeSO_4+2Fe_2O_3+H_2O,$$

showing 14 parts of copper to be reduced by 5 parts of iron, or 882 parts by weight of copper by 820 parts of iron. And in the case of the second equation the reduction of the



APPLIED TO THE TREATMENT OF OXIDIZED ORES.

cuprite would possibly be expressed as follows :—

$FeSO_4 + 3Cu_2O + 2Fe = 6Cu + FeSO_4 + Fe_2O_3$.

showing 6 parts of copper to be reduced by 2 parts of iron or 378 parts by weight of copper by 112 parts of iron.

Considerable testing was done with ferrous sulphate and iron, but it was found that in strong solutions of ferrous sulphate the iron was thrown out as ferrous oxide, rendering the mass dark and impeding recovery of the precipitate. This can be overcome by the addition of a little free acid or a soluble chloride, sodium or magnesium chloride being recommended.

The probable reaction from the use of ferrous sulphate and sodium chloride might be expressed as follows :—

$$3CuO + 2NaCl + FeSO_4 + 2Fe = 3Cu + Na_2SO_4 + FeCl_2 + Fe_2O_3.$$

This shows the iron consumption to be much the same as when using ferrous sulphate alone.

A further test to confirm the cyclic nature of the process can be made, and an equation expressing it may be as follows :—

$$3CuO + CuSO_4 + 3Fe = 4Cu + FeSO_4 + Fe_2O_3.$$

When the above is tried, sufficient iron to convert the copper sulphate to copper and ferrous sulphate must be used in excess of the amount required to reduce the copper in the ore, in order to obtain complete extraction.

It is claimed that no salts will be consumed in the operation of the process. It is fully realized that, should elements such as barium or calcium in certain forms be present, they would be converted to almost insoluble sulphates at the expense of the H_2SO_4, and there will also be small soluble losses in the slimes. It is not claimed that the consumption of iron will be a constant factor either, and the estimate is based on the practical results obtained in testing several mixed oxidized ores from West Australia, and in no case has the consumption exceeded 1 ton of iron for 2 tons of copper recovered.

TESTING ORES IN THE LABORATORY.—In advancing the theory of the process, it is the object of the inventors to endeavour to make the practical application understood ; therefore, the laboratory method used for testing is described.

Procure a large boiling tube about 10 in. long by 2 in. in diameter, together with stand and clip for holding it. Also a steam generating outfit ; a stoppered tin will do, with a rubber stop inserted and a glass tube passing through the stop to which connect a rubber tube. Convey the steam to a water trap, and then connect the tubing to a glass tube of sufficient length to reach the bottom of the boiling tube. Place tin after partially filling with water over a Bunsen burner, and allow steam to generate. Into the boiling tube put, say, 50 grams of finely ground ore, 50 cc. of water, and the amount of iron necessary to theoretically reduce the copper in the ore ; it is here recommended to use the iron in a fine state of division. Then add the required amount of acid, salt, or salts. Blow the steam through the mass steadily during the evolution of the CO_2, otherwise boiling over may occur. The steam will agitate the pulp sufficiently,

and the time of the operation can be varied, but usually the reduction of the copper is practically complete in about 10 to 15 minutes.

Wash the contents of the tube into a porcelain or suitable dish, and by the ordinary panning process the slime can be eliminated. The resulting precipitate is then dried, weighed, and assayed, and the strength of the acid or salts and the time occupied are noted.

It is advisable to add in the first testing 1 unit of iron for each unit of copper contained in the ore, and to take no count of the grade of the precipitate produced.

Ascertain what strength of acid or salt or salts produce the most coagulated precipitate, consistent with the highest extraction and the time of operation. The above points have a material influence on the application of the process, because in all cases it is preferable to produce a precipitate that can be easily recovered by an elutriation apparatus.

When the foregoing is ascertained, attention can be turned to the iron consumption. The method generally adopted is to add about one-third of the amount of iron that there is copper in the ore, and in subsequent tests to increase this amount until an increase of iron no longer increases the yield of copper. In testing for iron consumption, the use of the salts is recommended; otherwise, when using acid, allowance will have to be made for its reduction to the corresponding ferrous salt.

A description of several tests that have been made will here serve to support the theories advanced. (1) One hundred parts of oxidized ore from the Yannery Hills mine (referred to already) were taken. The ore had been previously ground to 150 mesh, and contained 19·7% of copper. To this, 500 parts by weight of water, and sufficient sulphuric acid to yield a 0·5% solution and 15 parts of fine iron were added, and steam passed through for 10 minutes. The precipitate was recovered by elutriation, and on weighing and assaying showed an extraction of 90% of the original copper contents. The solution that remained after the cement copper had been precipitated was separated before elutriation, and was added to another 100 parts of the same ore, together with 10 parts of iron, and after passing the steam through and recovering the precipitate, the result showed an extraction of 89% of the copper contents. This proves the cyclic and regenerative nature of the process, and in the second use of the solution the sulphuric acid had been reduced to ferrous sulphate. By coupling both tests, it is shown that 35 parts of copper were definitely reduced for a consumption of less than 2½ parts of acid without exhausting the reactive property of the solution. An excess of iron was used in both cases.

(2) A test on Whim Well ore, 150 mesh, in presence of chlorides, may also be given, the component parts being as follows:—100 parts of ore containing 6·6% copper, 3 parts of iron, 8 parts of ferrous sulphate ($FeSO_4$ $7H_2O$), 2 parts of sodium chloride, 100 parts of water. Steam was blown through for 15 minutes, and a 91% recovery of the copper contents was made. Upon using both stronger and weaker solutions of the above salts similar results were obtained.

GOLD, SILVER, AND OTHER METALS.—Another important fact in connexion with this process is that any gold and silver present in the ore are recovered at the same time as the copper. Tests carried out on a gold-copper ore have given as high as 84% extraction of the gold contents when carrying as high as 1 oz. of gold per ton. It is probable that the gold is recovered by a physical action, and tests made with a copper sulphate solution, iron, and gold leaf, in a beaker, show on boiling at first a sort of filmy electrodeposition of copper on the gold and then a complete entanglement of the gold by cement copper. Metallic silver if present would probably be recovered in the same manner.

This process is applicable to the separation of copper from zinc and lead. A test made on a dense sulphide ore, containing 13% copper, 28% zinc sulphide, and 40% lead sulphide, showed that after a dead roast, nearly the whole of the copper was extracted in a very short time.

ADDENDUM BY MR. MONTGOMERY.—I give herewith an account of tests during a visit to the works of the Australian Minerals Recovery Company, Ltd., the owners of the process:—

Experiments on a small scale were made by Mr. Nevill to demonstrate the operation of the process. Some very finely ground oxidized copper ore was boiled for six minutes by blowing steam through the liquid, with solutions of:—

(*a*) ½% sulphuric acid.

(*b*) Weak solution of ferrous sulphate.

(*c*) Weak solution of ferrous sulphate and some common salt.

(*d*) Copper sulphate solution and some common salt.

(*e*) Filtrate from test (*a*).

(*f*) Solution of ferrous sulphate and common salt.

A quantity of iron filings was added to tests (*a*) to (*e*) and several small wire nails to (*f*). In all cases there was strong effervescence owing to escape of carbonic acid gas from the carbonates in the ore, and a copious reduction of cement copper in a brown spongy form. By washing with water the finely ground earthy portion of the powdered ore was then easily separated from the heavy and somewhat coagulated cement copper, which was heavy and coherent enough to remain behind, while the lighter gangue was washed away. The separation was extremely easy, and Mr. Nevill claimed to have proved by quantitative tests that over 90% of the assay-value of various ores tried by him could be recovered as cement copper in this way. On a laboratory scale the reduction and separation of metallic copper are very simply effected, and the experiments certainly appear to show the foundations of a possible practicable process of treating oxidized copper ores.

Subsequently I had another interview with Mr. Nevill and Mr. Gillies, the company's chemist, and inquired into the determinations which had been made to establish the reactions shown in the inventor's description of its process. A good deal of quantitative testing is stated to have been done, and the company's operators were quite satisfied as to the soundness of their claim that the reduction of copper was effected with a much less consumption of iron than in any other previously known process in which iron is used to displace copper from its combinations. They seem well satisfied that the claims in their specification can be maintained, and that they have at least the beginnings of a valuable new method of recovering copper.

It is not advisable at present to make any report for publication in other than the most general terms, as it has not been possible for me to do more than look on at Mr. Nevill's demonstrations without opportunity to repeat them independently and quantitatively. A proper investigation would require several weeks' work in a chemical laboratory by a man devoting his whole time to the work. It seems to me that the process is of quite sufficient promise to warrant such a laboratory examination, and that it could be very usefully made.

If the fundamental reactions on which the process is based be confirmed by an independent laboratory revision and examination of them, and it be found that the reduction of the metal in the ore and its recovery as cement copper are practicable up to a high enough percentage of recovery of the copper to make the process a commercial success, there seems every reason to expect that the practical application of the process on a large scale will not be so difficult a matter as it would appear to be at first sight. There are two outstanding objections which occur to a reader of the description of the process almost at once, the first being the necessity for heating the pulp while it is being treated with the chemical solution. The operators say that a temperature of 70° C. has been found sufficient, but do not appear to have had good results at lower temperatures, even after prolonged contact of the ore with the solution. In the laboratory trials the solution is brought up to boiling point, and is very strongly agitated by the steam blown into it, and by the effervescence of the escaping carbonic acid gas when carbonate ores are being treated. On the large scale it is proposed to heat the pulp by steam coils, and a little injected steam in Pachuca vats. How the agitation is obtained is probably not very material to the process unless it be found that air brought into the solution may have a deleterious oxidizing effect on the ferrous sulphate, when mechanical stirring would seem preferable to agitation by air. Agitation by steam does not seem objectionable except for loss of steam. The objection is the probable cost of heating large tonnages of pulp to a temperature approaching boiling point, and of minimizing loss of heat in the subsequent treatment, while at the same time preserving a reasonable low working temperature for the men employed in handling the hot pulp.

The second obvious objection is that of probable loss of fine cement copper in the pulp while washing the earthy tailings away from the copper precipitate. In the laboratory experiments, however, even though the agitation is excessive compared with that which would be practicable on a large scale, the loss of copper in this way is stated by the operators to be remarkably low, and in the experiments seen by me the

cohesion of the spongy copper appeared to be very satisfactory, and to give good grounds for hoping that the loss by entanglement of fine copper in the tailings would be very small. Direct trials on a working scale alone can settle this point. Working with a 200 lb. sample, Mr. Nevill claims to have got an equally good recovery of copper as in his laboratory experiments. This is a very remarkable feature in the process, as *prima facie* the reduction of metallic cement copper throughout the pulp would be expected to involve great difficulty in getting anything approaching a complete separation by any simple washing process. After seeing the experiments, however, this difficulty does not seem to be really formidable. It will, nevertheless, require proof by actual working tests on a large scale that a satisfactory separation can be relied upon in actual practice.

The very fine grinding of the ore no doubt helps very greatly in washing the pulp readily off from the cement copper. With coarser sand the scouring of the copper might be expected to be considerable. Among the many things on which experimenting is still necessary, therefore, will be the fineness to which it is necessary to grind the ore in order to obtain the best results. Very fine grinding is much more costly in practice than reduction to grades of sand and slime such as are usually obtained in gold milling processes.

In four out of five of the experiments seen by me, the iron precipitant was in the form of iron filings, with the idea of presenting a large surface for deposition of copper. The other trial had the iron in the form of wire nails. As far as mere inspection could show, the cement copper was formed quite as readily and completely when the nails were used as with the filings, and it seems probable that lumps of iron scrap would act quite as well as finely powdered iron.

The chemical reactions on which the process is based are nearly related to others which are very well known and in constant use in the hydro-metallurgy of copper, but in my own reading on this matter I do not recollect having ever found any description of the particular conjunction of ferrous sulphate and metallic iron as a means of attacking oxidized copper ores which is used in this process. It may be quite well known, but the literature of the subject is so extensive that a very long search might be required to make sure of it if it has or has not been described before. The investigations made on account of the patentees are said by them to have given them assurance that their process is new in principle. The peculiarity of the process is that instead of bringing the copper into actual solution as copper sulphate or chloride, as in most wet methods of copper extraction and then separating the solution of copper from the insoluble part of the ore before precipitating the copper on iron or by electrolysis, the copper does not appear to be in solution at all more than at most momentarily. In presence of the metallic iron, the ferrous sulphate appears to reduce the copper oxides to metallic copper at once, the iron ions uniting with the oxygen and setting copper free, while corresponding amounts of iron enter the solution from the metallic iron filings or lumps. The process would seem to be very similar in a measure to the transfer of copper from an anode to a cathode in electrolytic copper refining, but in this case it would be ferrous sulphate which becomes polarized, and when an iron ion in contact with the ore particle as cathode displaces the copper by robbing it of its oxygen, it is at once replaced in the solution by another ion from the iron anodes. The curious result is that the ferrous sulphate solution remains entirely unaltered, and the consumption of material is confined to the metallic iron. The ferrous sulphate solution may be removed by filtering or decantation after freeing the copper, and may then be used over again. In practice this naturally would be greatly limited by the necessity for dilution of the pulp in order to separate the copper from the tailings by washing. The quantity of salt required, however, appears to be extraordinarily small compared with the consumption of chemicals in most wet-extraction copper processes.

In the experiment in which sulphuric acid was used, the solution contained only 0·5% acid. Doubtless it became more or less thoroughly converted into ferrous sulphate by acting upon the iron filings. In the case where copper sulphate was used as the solution, the copper was quickly reduced by the iron filings, leaving ferrous sulphate in its place. The effect of the common salt is probably to facilitate reactions which take place more readily with chlorides than sulphates in solution. Apparently saline waters would be preferable to fresh for this process.

A very important aspect of this process is the promise it holds out of recovery of gold as well as copper from ores containing both these metals. This has not yet been fully investigated. Remembering the results obtained at the Bellevue mine, Sir Samuel, by a process which depended on the adhesion of gold particles to cement copper, there seems to be much hope that a useful treatment might be evolved. There are several districts in West Australia where the presence of copper in the ore up to 1 or 2% has made it impossible to apply the cyanide process, and it would be well worth trying if extraction by cement copper might not take the place of amalgamation.

ADDENDUM BY MR. STOCKWELL.—The hydrometallurgical process for the recovery of metallic copper, which is the subject of the Australian Mineral Recovery Company's Patents, is, in general, based on the old reaction that the more electro-positive element iron in the metallic state displaces copper in the cement form from its solution.

Search has failed to reveal that the reaction has ever been applied commercially with :—

(*a*) Such low concentrations of reagents as the above patents claim.

(*b*) Such speed of interchange for such a high degree of metal extraction.

(*c*) Such a low consumption ratio of the metallic iron, it being usually less than 1 part of iron to 1 part of copper precipitated.

In general the copper is thrown out by passing steam into a pulp consisting of ore, a very weak solution of an acid, or a hydrolysable salt and metallic iron. A concentration of less than 0·5% of acid is all that is required to commence and maintain the action, provided excess of ore and the copper equivalent in metallic iron are present, and the following probably represents the main direction in which it proceeds :—

Copper ore (say, containing CuO) + $H_2SO_4 = CuSO_4 + H_2O$.

$CuSO_4 + Fe = Cu + FeSO_4$.

$2FeSO_4 + O + 5H_2O = 2Fe\ (OH) + 2H_2SO_4$.

$Fe\ (OH)_3$ and copper will accumulate, and all the copper from an unlimited quantity of ore will be precipitated by metallic iron for a limited and definite quantity of acid, the presence of air and agitation being conceded.

The process is differentiated from that of ordinary cementation by the fact that only an infinitesimal proportion of the acid radical equivalent for the metallic copper content of the ore is required to initiate and maintain the action, and the matter of solution in the ordinary accepted sense of the term cannot be granted.

The above equations show a regeneration of the acid. The reactions appear to be cyclic in nature, and under the conditions of agitation and enhanced temperature (for 60° C. to 70° C. seem to be the most favourable temperatures), the cycle is evidently one of great velocity.

Any salt which freely hydrolyses can be used in the process (with the same results as with free acid) for the supply of the acid radical or ion, its efficiency being dependent upon its tendency to hydrolyse. Thus, mineralized mine waters are usable, and if copper-charged, all the better.

A cheap commercial by-product in ferrous sulphate has been found most suitable, and its use obviates the difficult transport of a dangerous substance such as concentrated sulphuric acid.

With some ores (when using ferrous sulphate), it may be found an advantage to introduce at the outset a little free acid for the purpose of accelerating or giving an impulse to the initial step in the cycle.

In order to provide metallic iron cheaply, the manufacture of sponge iron can be resorted to. High-grade iron ore can be reduced to metal without smelting, or fluxing, by heating it in a highly reduced atmosphere yielding a finely divided product containing up to 70% metallic iron. Any good iron ore may be converted into sponge iron, or copper concentrate residues after being roasted and the copper extracted can be used for the purpose. A research which offers prospects of good results is the treatment of copper concentrates in such a manner that the sponge iron may be formed from the iron portion of the copper and iron sulphide concentrate, the whole mass being then agitated in the Pachuca as before.

A selective sulphatizing roast can be made to yield enough salts to bring about the necessary reaction.

From personal observation and investigation I am led to the opinion that the process possesses great potentialities. The advantages claimed in the matter of control, low cost of chemical treatment, percentage of recovery, combined with the increased efficiency and modifications which will no doubt be introduced on further development, I am confident will convince copper men that the process is a valuable one and easy of application on a commercial scale.

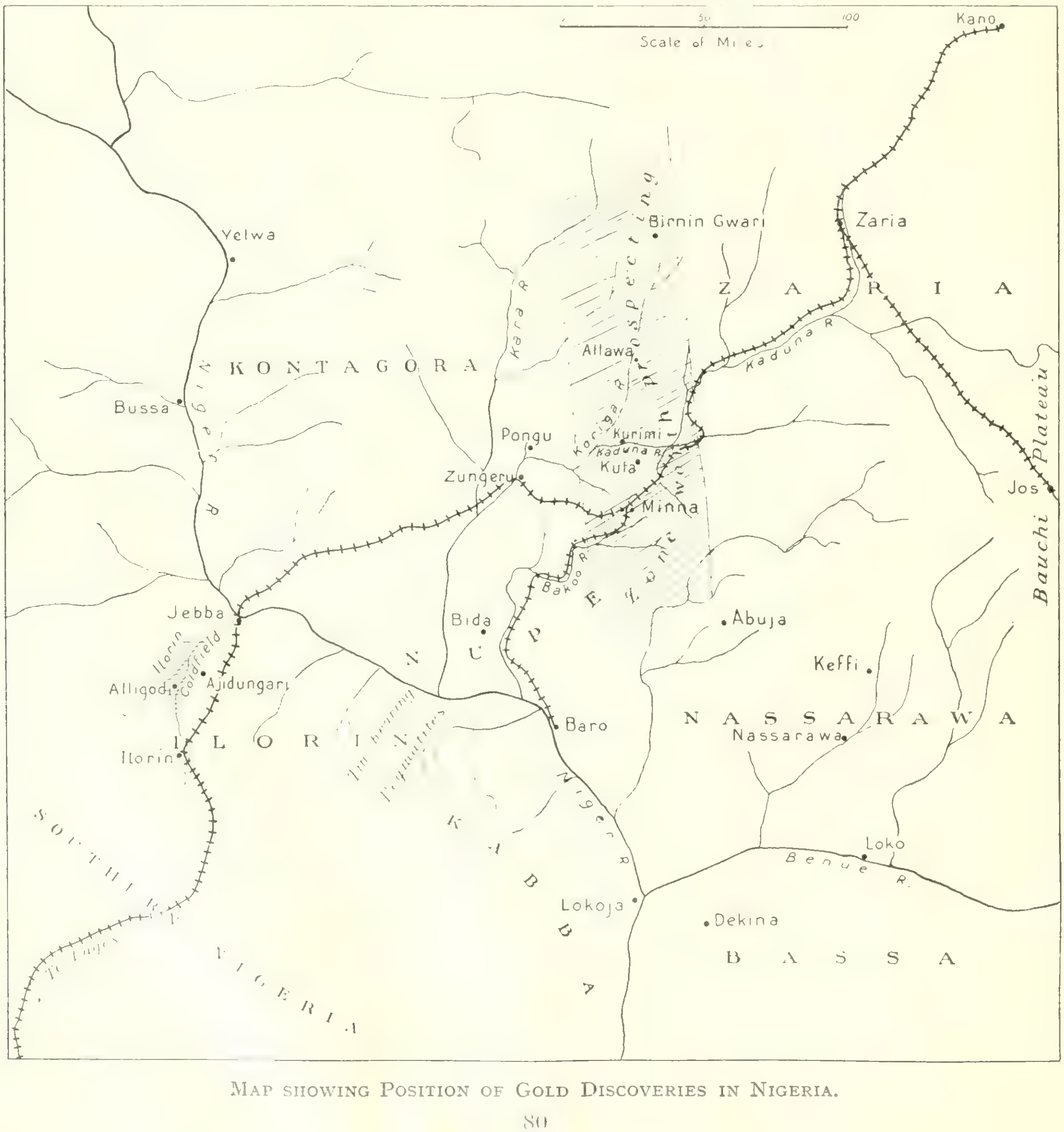
GOLD PROSPECTS IN NIGERIA

By WALLINGTON A. POPE, A.R.S.M., Assoc.Inst.M.M.

The author briefly records his impressions of the chances for finding gold in Nigeria.

In the autumn of last year, when there was much talk in London of possible goldfields in Nigeria, the writer was sent out by a London company to investigate. It is by the courtesy of this company that he is able to write a few notes on his observations.

The area attracting greatest attention was situated some 24 miles to the north of Ilorin town. Here large blocks had been pegged. Colours of gold had been found in the river bed by an enterprising railway engineer when out shooting some two years previously. He mentioned this to a mining man, who went to investigate. Rumour reached the Plateau, and pegging followed. The position in January was that large areas were held, but, with the exception of the work of one man, who was costeening, not a stroke of work had been done, and in no case had a sample been taken outside the



Map showing Position of Gold Discoveries in Nigeria.

river bed that showed a colour of gold. The river bed and terraces occasionally carried small much-travelled colours of gold.

On going north from Ilorin, granite country is passed over. About 16 miles from the town the most southerly area pegged was reached; here a large buck quartz reef runs through granite country, and forms a hog's back. At Alligodi, some 8 miles to the north of this, the southern block of the large areas pegged was entered, granite changing to gneissose granite, with great granite boulders and ridges further to the north. Great quartz blows carry a little pyrites in places; at such points many samples have been broken from the quartz.

The geology of Ilorin makes it very unlikely that a goldfield will be found in that province, but to the north-east, after crossing the Niger River, the formation changes from granite to gneissose granite and schist, and the rivers and terraces carry gold which gives the impression of being the result of denudation over a long geological period.

In the Kaduna River, at Zungeru, in the gneiss, colours of travelled gold can be obtained in every dish washed from good crevices. Following the river to the north, gold can be obtained in increasing numbers of colours from the river bed and terraces. At Pongu, gneissose hills rise to 2,000 ft. above sea-level. East from Pongu a great variety of gneissose rocks and schists are passed over, running generally in a N.W.–S.E. direction. Some 10 miles to the east of Pongu, granite breaks through and the country for the next 10 miles is mainly granite. Then gneiss and schist again occur, with occasional inselbergs of granite.

Just below the junction of the Kaduna and Koriga Rivers gold has been worked from the alluvial in the river bed. Above the junction the Kaduna River carries in the bed, in addition to the travelled colours, some larger pieces of little-travelled contact gold. The quartz stringers cutting through the gneiss do not carry gold.

Some three miles up the Kaduna River from the junction a granite intrusion cuts out the coarse colours, and a little porphyry is to be found. Farther up gneiss and schist with granite inselbergs are again found. The course of the river has changed many times, giving extensive terraces, all of which carry colours of travelled gold.

At Kurimi the bed of the river has been confined by harder country, and alluvial gold is being won on a small scale from the river bed. Gold has been worked at Allawa on the Koriga River, at a point or two south of Minna, on the Bakoo River, and at other odd places, according to rumour, in a small way. As is well known, gold is being worked from a schist formation at Birnin Gwari.

The shading on the plan, with Birnin Gwari in the north and Minna in the south, indicates an area which in the author's opinion is the most hopeful in which to find a goldfield. Schist country is to be frequently met with, and as all the alluvial gold found in the rivers indicates that it is shed from schist, with the exception of a little contact gold, it would seem that it is possible for a find to be made in schist anywhere within the area.

This area, some 100 miles long by 40 miles wide, has received very little attention from the prospector. It has been run over in the vicinity of the rivers, and at Birnin Gwari, but most of it has never been even run over. It is not the sort of country where hundreds of ounces will be "specked"; a find will be the reward of patient, scientific prospecting.

The writer has not been on the field above Kano, nor on the western side of the colony in the vicinity of the Niger River, where also it is possible that further finds may be made.

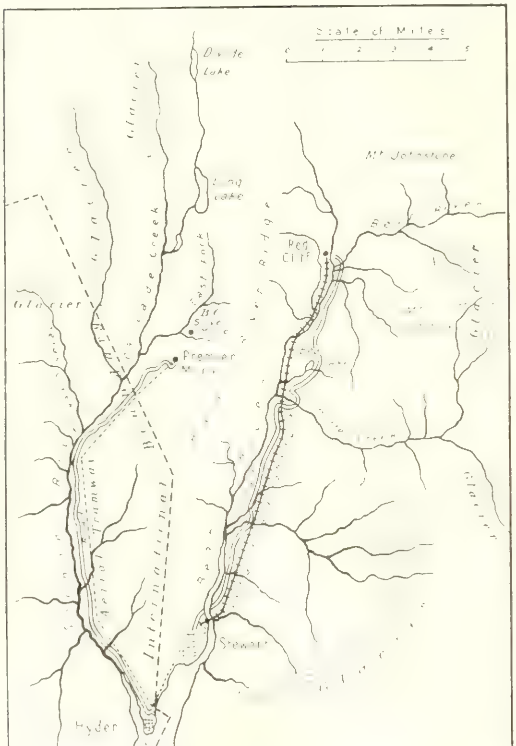
Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute will be held in the Museum Theatre, York, on September 5 and 6. The following papers will be submitted: The Changes of Volume of Steels During Heat Treatment, (1) Air Hardening Nickel Chromium Steels, by L. Aitchison; Nitrogenization of Iron and Steel by Sodium Nitrate, by L. E. Benson; A Brinell Machine Attachment for Use with Small Specimens, by E. D. Campbell; A Preliminary Magnetic Study of Some Heat-treated Carbon Steels, by E. D. Campbell and H. Johnson; Some experiments on the Flow of Steels at a Low Red Heat, with a Note on the Scaling of Heated Steels, by J. H. S. Dickenson; An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands, by C. W. H. Holmes; Practical Notes on the Manufacture and Treatment of High-speed Steel, by H. K. Ogilvie; The Basis of Modern Blast-furnace Practice, by A. K. Reese; Reversing Cogging Mills: Their Drives and Auxiliary Equipment, by G. A. V. Russell; The Diminution of Lag at Ar 1 through Deformation, by H. J. Whiteley.

THE PREMIER MINE AERIAL ROPEWAY

By F. H. MASON

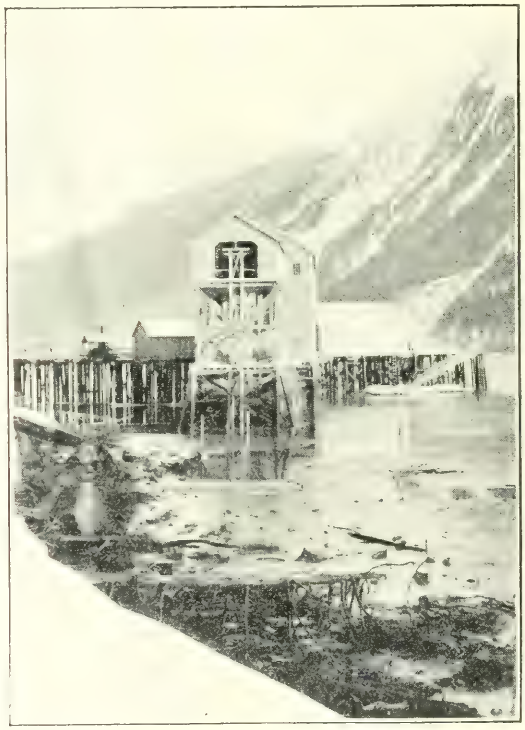
The Author gives particulars of the method of transport from British Columbia's great gold mine to the Coast.

The readers of the MAGAZINE have been fairly well posted in the doings at the Premier gold mine in Northern British Columbia, as regards its discovery and development and its current history. The richness of its ore makes the mine the most important of recent new producers. The ownership is with the Guggenheims, otherwise the American Smelting and Refining Company; but what is most interesting to English readers is that the Selukwe Gold Mining and Finance Company controls a neighbour, the B.C. Silver Mines, Ltd., which was taken up at the recommendation of Mr. C. A. Banks. The negotiations as to the future handling of the B.C. Silver Mines are now going on.



MAP OF SALMON RIVER DISTRICT, SHOWING POSITION OF PREMIER MINE.

One of the great difficulties in the development of the Premier lay in the matter of communications. Some account of the way in which this difficulty was surmounted will be of interest. When the Premier Company started to develop the mine and bring it up to the stage of production which the exploration that had been done on the ore-bodies undoubtedly warranted, it was the intention to devote the spring, summer, and autumn months to the extraction of ore and to the milling of the medium-grade and low-grade ore, and to concentrate work during the four winter months to the transport of the high-grade ore and concentrate from the mine to tide-water. It should be explained that the Premier is situated some 15 miles up the Salmon River valley from the head of the Portland Canal. This Canal is a natural inlet, about 100 miles in length, forming the southern part of the boundary between British Columbia and Alaska. The valley is precipitous and difficult country, entirely unsuited for the maintenance of roads over which heavy loads have to be hauled; there often are heavy rainfalls in



DISCHARGE TERMINAL AT SEA BOARD.

summer, and usually heavy snowfalls in winter. It was thought that the last might be taken advantage of for the transport of ore, and fifty or sixty powerful horses were assembled at the mine with that end in view. The frequent necessity for "breaking" the road after each heavy snow-storm made the work of transport of ore tedious and slow, and in the year 1919 only 488 tons was moved from the mine. In the summer of the following year two 5-ton Hold caterpillar tractors were added to the hauling equipment, and in that year 799 tons of ore was transported from the mine to tide-water and thence to the smelter at Tacoma. A thaw in the middle of the winter of 1920–21 so interfered with the movement of ore that it became evident some better form of transport must be provided if the Premier was to become the big mine that the development of the ore-bodies clearly foreshadowed. Accordingly, in March, 1921, a contract for the construction of an aerial tramway between the mine and tide-water was let to the Riblet Tramway Company, of Spokane, Washington. The tramway was put into operation on December 21 of the same year, despite of strike of several weeks' duration in the middle of the summer, when the best work should have been done.

Angle Station.

Tension Station.

The tramway is $11\frac{1}{4}$ miles (59,400 ft.) long. The main track cable, which carries the loaded buckets, is 1 in. in diameter, and is of specially smooth coil construction; the return cable is $\frac{7}{8}$ in. diameter; the running cable is of $\frac{5}{8}$ in. plow-steel. The several lengths of the track cable are coupled together with 110 nickel-steel couplings, and are supported on 153 towers; the running cable is in one piece, and is supported on 385 self-lubricating, steel sheaves. The extremely rugged nature of the country made a straight line tramway impracticable; there are, therefore, three angle stations, deflecting the tramway 46°, 26°, and 99° respectively, making a total of 171°, or only 9° less than half a circle. The last and greatest deflection is at the lower end of the tramway, between the towns of Hyder and Stewart. The loading terminal is 1,337 ft. above the discharging terminal, which is situated on the wharf at Stewart. The tramway is operated by a 50 h.p. electric motor, geared to the bull wheel at the upper terminal, but with all buckets loaded the

tramways absorbs only 30 h.p. The tension of the cables is adjusted at the two terminals and the three angle-stations. The driving arrangements provide for a starting speed of 125 ft., and a normal running speed of 500 ft. per minute. At present the tramway is provided with 125 buckets, each having a capacity of about 800 lb. of ore; this is calculated to give it a capacity of about 100 tons per eight-hour shift. Arrangements are provided for increasing the number of buckets to 360, and in this way the capacity of the tramway will be increased as the mine is developed. At the present time the tramway is being operated for two eight-hour shifts daily, and is delivering about 1,600 tons per week.

The ore-bunkers at the discharging terminal have a capacity for 1,500 tons of ore, and on the ground floor there is storage room for 1,000 tons of sacked concentrate. The ore is drawn from the bunkers through chutes on to an attached belt-conveyor, which transfers it to a removable belt-conveyor. This latter conveyor is erected only during loading operations, and it takes the ore directly to the ship or scow that is being loaded. There is an incline from the warehouse on the wharf to the terminal floor, where a gasoline-driven winding engine hauls up freight that is to be sent to the mine by the tramway. An electric-lighting plant provides illumination for operating the tramway or for loading the ships at night, a necessary addition in that northern region, where during the winter the days are very short. The two terminals and three angle-stations are connected by telephone. The line is divided into three sections, over which patrols are maintained continuously while the tramway is in operation. During the first three months of the present year the tramway delivered approximately 18,000 tons of ore and concentrate. Unfortunately the company says nothing about the value of the ore.

METALS DURING 1921.

STATISTICS OF PRODUCTION, IMPORTS AND EXPORTS OF COPPER, TIN, LEAD, ZINC, SILVER, ARSENIC, AND IRON THROUGHOUT THE WORLD.

Prepared by the Imperial Mineral Resources Bureau.

COPPER.

			Long Tons.
UNITED KINGDOM.	Imports.	Bars, blocks, etc.	84,320
	Exports.	Bars, blocks, etc.	10,885
NORTHERN RHODESIA.	Production.	Finished copper.	196
SOUTHERN RHODESIA.	Production.	Blister copper.	2,750
	Exports.	Bar, blister, and ingots.	3,016
UNION OF SOUTH AFRICA.	Production.		141
	,,	Metal content.	92
	Imports.	Bar, rod, ingot.	20
	Exports.	Ore and regulus.	183
SOUTH-WEST AFRICA PROTECTORATE.	Production.	Copper-lead ore.	72,643
	Exports.	Copper-matte.	1,414
CANADA.	Production.		23,867
	Imports.	Ore and concentrates.	1,228
	,,	Blocks, pigs, or ingots.	413
	Exports.	Fine copper in ore, etc.	4,692
	,,	Blister copper.	14,767
	,,	Pigs, bars, sheets, etc.	1,453
INDIA.	Imports.	Unwrought copper.	504
	Exports.		77
AUSTRALIA.	Production.		10,971
	,,	Refined copper produced in Australia, and metal in blister, matte, ore, etc., exported.	18,634
	Exports.	Refined copper.	12,082
	,,	Copper in blister, matte, ore, etc.	34
BELGIUM.	Imports.		15,296
FRANCE.	Imports.	Ore and concentrates.	6,459
	,,	Cement, crude, ingots, anodes.	48,029
	Exports.	Ore and concentrates.	1,492

(*Copper continued.*)

			Long Tons.
FRANCE.	Exports.	Cement, crude, ingots, anodes.	3,779
ITALY.	Production.	Ore.	22,300
	,,	Metal.	97
NORWAY.	Exports.	Ore.	561
	,,	Crude and refined.	1,016
RUSSIA.	Production.	Ore.	4,600
BELGIAN CONGO.	Production.		29,978
MADAGASCAR.	Exports.	Copper.	4
UNITED STATES.	Production.	Refinery production from domestic sources.	268,300
	,,	Ditto from foreign sources.	142,900
			411,200
	Imports.	Ore, concentrates, matte, regulus, coarse metal, cement, etc.	379,428
	,,	Copper content thereof.	45,893
	,,	Unrefined, black, blister and converter copper.	76,668
	,,	Refined copper.	30,915
	Exports.	Ore, concentrates, matte and regulus.	1,744
	,,	Copper content thereof.	161
	,,	Unrefined, black, blister and converter copper.	67
	,,	Refined copper.	266,124
CHILE.	Exports.	Bars.	46,988
	,,	Matte.	319
	,,	Ore.	47,926
JAPAN.	Production.	Copper.	52,304

TIN.

			Long Tons.
United Kingdom.	Production.	Cornwall only.	700
	Imports.		20,967
	Exports.		9,900
Nigeria.	Production.	Concentrates.	7,225
Southern Rhodesia.	Production.		4
Union of South Africa.	Production.		1,408
	,,	Metallic content.	920
	Imports.		124
	Exports.	Concentrates.	1,529
South-West Africa Protectorate.	Production.	Concentrates.	156
Swaziland.	Production.	Concentrates.	383
Federated Malay States.	Exports.	Tin and tin contained in concentrates.	34,489
India.	Imports.		2,656
	Exports.	Concentrates.	81
Australia.	Production.		2,650
	,,	Refined tin produced in Australia, and metal in ore and concentrates exported.	2,990
	Exports.	Refined tin.	1,704
	,,	Tin in ore and concentrates exported.	5
Belgium.	Imports.		1,731
France.	Imports.	Ore.	358
	,,	Metal.	6,998
	Exports.	Ore.	27
	,,	Metal.	506
Germany.	Imports.	Ore.	2,273
Norway.	Imports.	Crude metal.	130
United States.	Imports.	Ore and oxide.	13,696
	,,	Bars, blocks, pig or granulated.	24,197
	Exports.	Pigs, bars, etc.	1,031
Bolivia.	West Coast shipments.	Metal in ore.	17,414
China.	Production.		8,500
Banka.	Production.		12,125
Billiton and Singkep.	Production.		7,000

ZINC.

			Long Tons.
United Kingdom.	Production.	Spelter.	10,000
	Imports.	Spelter.	72,486
	Exports.	Crude and manufactured.	7,424
Northern Rhodesia.	Production.	Ore.	18
Union of South Africa.	Imports.	Unmanufactured	1,372
Canada.	Production.	Smelter production.	23,703
	Imports.	Spelter.	496
	Exports.	Ore.	46
	,,	Spelter.	11,454
India.	Imports.	Spelter.	3,100
	Exports.	Zinc or spelter of all kinds.	4,000
Australia.	Production.	In lead and zinc concentrates.	139,460
	,,	Refined metal produced in Australia, and metal in ore and concentrates exported.	21,297
	Exports.	Spelter and zinc.	1,043
	,,	In concentrates and ores.	19,616
Belgium.	Production.	Spelter.	65,402
	Imports.	Ore.	186,057
	Exports.	Spelter.	37,581
France.	Imports.	Ore.	40,717
	,,	Crude zinc.	11,190
	Exports.	Ore.	8,154
	,,	Crude zinc.	4,829
	Production.	Ore.	2,708

(*Zinc continued.*)

			Long Tons.
Germany.	Production.	Spelter.	120,000
Italy.	Production.	Ore.	68,000
	,,	Spelter.	370
Netherlands.	Production.	Spelter.	3,000
Norway.	Production.	Spelter.	12,000
	Imports.	Spelter.	6,955
	Exports.	Spelter.	16,930
Poland.	Production.	Spelter.	5,000
	,,	Ore.	56,900
Sweden.	Production.	Spelter.	6,000
Algeria.	Exports.	Ore.	17,255
Tunis.	Exports.	Ore.	7,686
United States.	Production.	Primary metallic zinc.	
	,,	From domestic ores.	176,993
	,,	From foreign ores.	2,025
			179,018
	,,	Re-distilled secondary zinc.	15,690
	,,	Total of distilled electrolytic zinc.	194,708
	Imports.	Ore.	6,731
	,,	Lead content of ore.	2,415
	,,	Blocks, pigs, and old.	6,017
	Exports.	Pigs, slabs, etc.	2,136
Japan.	Production.	Spelter.	7,000

LEAD.

			Long Tons.
United Kingdom.	Imports.	Pig and sheet.	132,602
	Exports.	Pig lead.	11,098
Northern Rhodesia.	Production.	Lead.	17,686
	Exports.	Pig lead.	18,348
Union of South Africa.	Production.	Ore.	189
	Imports.	Pig and sheet.	362
	Exports.	Ore.	4
South-West Africa Protectorate.	Production.	Copper and lead ore.	72,643
	Exports.	Raw lead.	198
Canada.	Production.	Refined lead.	25,732
	Imports.	Bars, sheets, pig and block.	492
	Exports.	Pig lead and lead contained in ore.	13,408
Burma.	Production.	Lead.	25,000
India.	Imports.	Lead ore.	102
	,,	Pig lead.	311
	Exports.	Pig lead.	30,624
Australia.	Production.	Lead contained in ore and concentrates.	83,878
	,,	Refined metal produced in Australia, and metal in bullion and in ore and concentrates exported.	62,777
	Exports.	Pig lead and lead bullion.	33,749
	,,	In concentrates and ores.	6,448
Belgium.	Imports.	Lead.	16,384
	Exports.	Lead.	25,133
France.	Imports.	Ore.	13,773
	,,	Pig lead, argentiferous and non-argentiferous.	33,043
	Exports.	Ore.	3,685
	,,	Pig lead, argentiferous and non-argentiferous.	8,917
	Production.	Ore.	5,533
Germany.	Production.	Lead.	65,000
Italy.	Production.	Lead ore and argentiferous lead ore.	26,100
	,,	Lead.	11,300
Norway.	Imports.	Crude lead.	124
Russia.	Production.	Lead-zinc ore.	3,710

LEAD (*continued*).

			Long Tons.
Spain.	Production.	Lead.	100,000
Algeria.	Exports.	Ore.	11,237
Tunis.	Exports.	Ore.	5,901
	,,	Metal.	14,985
Mexico.	Exports.	Metal.	59,541
United States.	Production.	Primary domestic lead.	170,000
	,,	Soft lead.	129,500
	,,	Desilverized soft lead.	49,000
	,,	Refined lead from domestic ores.	348,500
	,,	Smelted and refined from foreign ore and bullion.	44,500
	,,	Total lead smelted or refined.	393,000
	,,	Antimonial lead.	7,100
	Imports.	Lead content of ore and bullion.	38,378
	,,	Pig, bar and old.	27,948
	Exports.	Pig and bar.	23,515

SILVER.

			Fine Oz.
United Kingdom.	Imports.	Silver bullion, unrefined.	5,787,244
	,,	Silver bullion, refined.	40,245,164
	,,	Silver coin, of legal tender in U.K. (Face, or currency value.)	£1,525,520
	,,	Silver coin, not of legal tender in U.K. (Value of commodity.)	£1,303,454
Northern Rhodesia.	Production.		8,867
Southern Rhodesia.	Production.		152,989
Union of South Africa.	Production.		830,339
Canada.	Production.	Silver.	13,134,926
	Exports.	Silver in ore, concentrates, etc.	1,537,980
	,,	Bullion.	7,258,954
India.	Imports.		55,919,954
	Production.	Bawdwin metal.	3,827,904
Australia.	Production.	In lead and zinc concentrates, in other ores and concentrates, treated in Australia or exported, and in gold bullion treated at Australian mints.	8,326,006
	,,	Refined silver produced in Australia, and metal in unrefined products, ore, and concentrate exported.	5,304,950
	Exports.	Bar, ingot and sheet.	2,711,729
	,,	Silver contained in matte.	58,860
	,,	Silver contained in ores and concentrates.	667,261
France.	Imports.	Beaten, drawn, rolled and thread.	89,184
	,,	Crude, in ingots.	[illegible]
	,,	Coin.	368,889
	Exports.	Beaten, drawn, rolled and thread.	[illegible]
	,,	Crude, in ingots.	6,876,756
	,,	Coin.	[illegible]
Italy.	Production.		209,330
Mexico.	Production.		64,465,347
United States.	Production.		50,364,389

ARSENIC.

			Long Tons.
Southern Rhodesia.	Production.		322
Canada.	Production.	White arsenic and arsenic in ore.	1,331
Queensland.			220
New South Wales.	Production.	White arsenic.	397
France.	Imports.	Metal.	5
	Production.	Ore.	577
United States.	Production.		5,118
	Imports.	Arsenic and sulphide of arsenic.	2,985
Mexico.	Production.	White arsenic.	772

IRON.

			Long Tons.
United Kingdom	Production.	Pig iron.	2,611,400
	Imports.	Iron ore, including manganiferous iron ore.	1,887,574
	,,	Pig iron, including ferro-alloys.	681,955
	Exports.	Iron ore, including manganiferous iron ore.	1,472
	,,	Pig iron, including ferro-alloys.	135,998
Union of South Africa.	Production.	Iron ore.	2,157
	Imports.	Pig and ingot.	1,023
Canada.	Production.	Iron ore.	38,337
	,,	Pig iron and ferro-alloys.	616,847
	Imports.	Iron ore.	590,329
	Exports.	Iron ore.	3,804
India.	Imports.	Iron ore.	9
	,,	Pig iron.	14,129
	Exports.	Pig iron.	51,942
	Production.	Ore 1901 Act.	286,190
Australia.	Production.	Iron ore.	689,275
	,,	Pig iron.	352,365
	Exports.	Pig iron.	2,765
Austria.	Production.	Iron ore.	670,000
	,,	Pig iron.	226,000
Belgium.	Production.	Pig iron.	862,305
France.	Production.	Iron ore.	13,879,000
	,,	Pig iron.	3,362,038
	Imports.	Iron ore.	418,196
	,,	Pig iron and ferro-alloys.	37,266
	Exports.	Iron ore.	5,212,845
	,,	Pig iron and ferro-alloys.	648,960
Germany.	Production.	Pig iron and spiegeleisen.	8,000,000
Italy.	Production.	Iron ore.	275,480
Luxemburg.	Production.	Pig iron.	954,871
Norway.	Imports.	Pig iron and ferro-silicon.	5,877
	Exports.	Iron ore.	188,151
	,,	Pig iron and ferro-chrome.	1,088
Poland.	Production.	Ore.	234,000
Soviet Russia.	Production.	Pig iron.	967,741
Spain.	Imports.	Pig iron.	24,135
	Exports.	Iron ore.	1,795,428
	,,	Pig iron.	4
Sweden.	Production.	Pig iron.	303,640
	,,	Ore.	6,360,456
Switzerland.	Imports.	Pig iron.	24,282
Algeria.	Exports.	Iron ore.	673,956
Tunis.	Exports.	Iron ore.	200,733
United States.	Production.	Iron ore.	29,547,000
	,,	Pig iron.	16,688,126
	Imports.	Iron ore.	315,768
	,,	Pig iron and ferro-alloys.	44,516
	Exports.	Iron ore.	440,106
	,,	Pig iron and ferro-alloys.	28,305

MESOPOTAMIA

A REVIEW OF ITS GEOLOGY AND PETROLEUM RESOURCES

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The publication of a new memoir of the Geological Survey of India, entitled "Geological Notes on Mesopotamia with special reference to the Occurrences of Petroleum," by Dr. E. H. Pascoe, brings this much-discussed territory again to the fore, and renders the moment opportune for a brief review of the economic potentialities of that country.

While in England, both in Parliament and in the Press, opinion is sharply divided on the issues occasioned by our foreign policies in the Near East, more particularly over the expenditure of vast sums of public money on the stabilization of Mesopotamia as a political unit, there seems to be a general consensus of agreement that the future of that country is assured, once the constitution becomes more settled. The basis of optimism in this case is to be found in the belief that the natural resources of Mesopotamia are extensive, varied, and of great commercial value, and of these resources petroleum figures as being the most important asset.

There is, as a matter of fact, a good deal of loose thinking with regard to Mesopotamian oil, judging by the trend of much that has appeared in the Press on both sides of the Atlantic of late, and also by the many discussions the writer has heard on the subject in this country. Some people seem to have the idea that a large producing field already exists in Mesopotamia, others believing that it is only a matter of a few months before developments will mature and production on a commercial scale be maintained. To the careful observer, however, the true state of affairs is soon revealed, once the evidence is sifted from the mass of political and commercial exaggeration which envelops it, and it is easily recognized that before anything like success is obtained, or even contemplated, an enormous amount of work awaits prosecution.

The widespread reputation of this territory as a petroliferous region is, of course, largely built up on the assumption that geologically it forms a direct continuation of the well-known Persian oilfields, and that, *ceteris paribus*, the same measure of success should follow exploration for oil in Mesopotamia as in those fields. Broadly speaking, the assumption is reasonable, but even with our restricted knowledge of the geology of the country, it is evident that future results will be contingent on natural conditions dissimilar in certain respects from those obtaining farther south, and consequently prophecy should be tempered with that amount of caution merited by the nature and breadth of the problems involved.

Several investigators contributed to our knowledge of Mesopotamia before the war, Blanckenhorn, Höfer, Loftus, de Morgan, Oswald, Pilgrim, and Stahl being well known (see bibliography in Admiralty publication mentioned below). Military operations during the war led to a much wider acquaintance with the country, its people, and internal resources, and also to a far more precise topographical knowledge as a result of reconnaissance supplemented by captured enemy maps of certain districts. Another outcome of British intervention here was the publication last year of a book on the "Geology of Mesopotamia and its Borderlands," compiled by the Geographical Section of the Naval Intelligence Division, Naval Staff, Admiralty; in this book, strict anonymity is observed in so far as individual contributors are concerned, and this, taken in conjunction with the appearance of the volume at a time when political dissention regarding Mesopotamia was specially strong, constituted ground for much current speculation. Although obviously written with the intent of advertising Mesopotamian oil resources, it contributed (as Professor Madgwick pointed out in the MAGAZINE for August, 1921) singularly little of practical value to the oil man. On the other hand, as a broad summary of the geology and economics of the region, and on account of the maps included, it has proved itself a useful publication. Again, the paper by Messrs. Busk and Mayo dealing with the Persian oilfields, published in the *Journal* of the Institution of Petroleum Technologists for 1918, another by C. M. Hunter, appearing in *Bulletin* 158 of the American Institute of Mining and Metallurgical Engineers, 1920, and a third

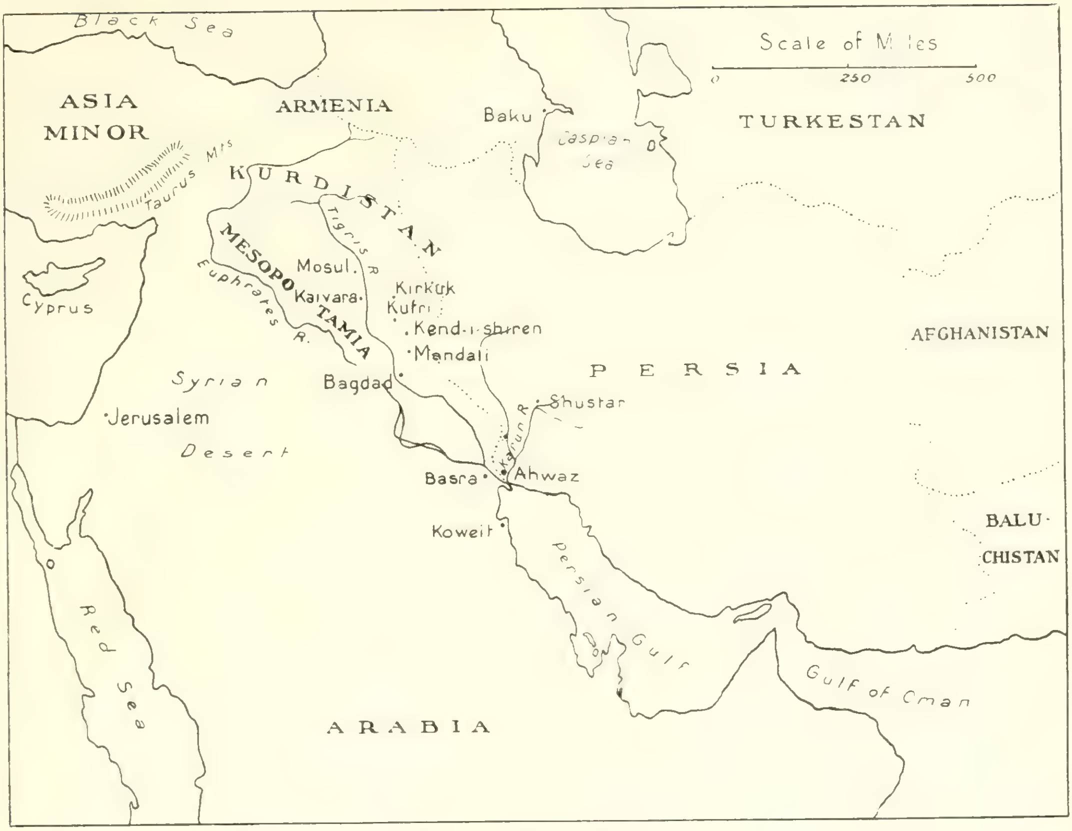
by E. M. Spieker, published in the *Engineering and Mining Journal* for August 14, 1920, are three recent publications having a direct bearing on Mesopotamia, while this latest contribution by Dr. E. H. Pascoe brings our knowledge of the region up to date.

Physiographically, Mesopotamia may be regarded as an enormous depression striking N.W.–S.E., bounded on the north by the Taurus and Armenian mountains, on the S.W. by the Arabian plateau, and on the N.E. by the fold-mountains constituting the Persian arc. Its S.E. extension is to the Persian Gulf, a relic of the sea which once stretched much farther north than at the present time, and which, by continual deposition of sediment brought down by the Tigris and Euphrates and their tributaries causing gradual deltaic advance, is slowly retreating southward. This Mesopotamian depression corresponds geographically, and in many respects geologically, to similar elements of structure characteristic of Southern Asia, such as the Indo-Gangetic plain, and in this fact lies the explanation of the close analogy between the oil occurrences in Mesopotamia, Persia, Baluchistan, N.W. India, and Burma.

Although Mesopotamia is frequently described as a broad plain, it really presents two contrasted features, Lower Mesopotamia or the Euphrates-Tigris plain proper, and Upper Mesopotamia (Jezireh), comprising the upland plains extending from north of Baghdad to the Taurus mountains. Geologically the lower region consists principally of alluvium overlying younger Tertiary deposits, forming the monotonous country between Baghdad, Basra, and the Persian Gulf. Upper Mesopotamia may be regarded as a plain intersected by several low parallel ridges composed of Tertiary deposits and volcanic rocks, the latter developed particularly in the north. These features, in so far as they give evidence of geological structure, suggest the presence of N.W.–S.E. folds conforming to the trend of the main Persian arc to the east.

The Tertiary deposits with which the oil is associated, closely resemble corresponding formations to the S.E., in Persia. The most important beds are those containing gypsum with sandstone and limestone, of Miocene age, and probably corresponding to the Lower Fars Series (Pilgrim) of Persia. These beds are for the most part marine, but they give place towards the top to beds characteristic of lagoonal and fluviatile phases of deposition, the Passage Beds. Their base is not seen in this region (Pascoe). The overlying rocks consist of a series of red clays and sandstones, possibly the equivalent (in part) of the Bakhtiyari Series (Pilgrim) of Persia, but considered by Dr. Pascoe to be of fluviatile origin and provisionally named by him the "Kurd Series," a name having much to commend it. This series, as exposed in the region examined by Dr. Pascoe, is divisible into lower and upper divisions, the former comprising *a*, *b*, and *c* phases and consisting chiefly of clays and sands, the latter including the *d* and *e* phases, denoting beds that are strongly conglomeratic. The relationship of the Kurd to the Fars Series seems at present to be a matter of doubt; at all events, precise correlation between the Mosul-Baghdad and the Persian Gulf regions is impossible at this stage of investigations.

The Mesopotamian oil region, as at present comprehended, embraces an area extending from Mosul south-eastward to Mandali (E.N.E. of Baghdad), occupying a tract of country some 220 miles long and 80 miles broad, bordering the Persian front, and drained by the Tigris. Dr. H. Höfer (Die Erdölvorkommen in Mesopotamien und Persien, *Petroleum-Zeitschr.*, vol. i, pp. 781–7, and pp. 819–24, 1906) has described the principal surface indications of petroleum, including sulphur springs and gypsiferous deposits, within this area, and has related them to three parallel lines of movement, known as the "Mesopotamian Lines." The most important of these is the one nearest the Persian front, stretching from Mosul and passing through Hammam Ali (sulphur springs), Kirkuk (petroleum), near Tuz Khurmatu (oil-springs at Neft Dagh, the "oil mountain"), and through Kend-i-Shirin (petroleum). This line—known as the "Kirkuk Line"—if prolonged to the S.E., is collateral with the main line of folding of the Ahwaz district (Maidan-i-naftun, etc.) of Persia. The second line or the "Kaivara-Kufri Line," to the S.W. of the previous one, starts about 40 miles south of Mosul at Tel Kaivara (petroleum seepages), extending beyond Kufri (petroleum) to Jebel Oniki Imam, and embraces several intermediate oil occurrences. The most westerly line, the "El-Fet-hah-Mandali Line," starts with the oil seepages of El Hadhr ruin, 50 miles S.W. of Mosul, and extends through the Fet-Hah defile (petroleum) to Mandali, some 70 miles E.N.E. of Baghdad, where the



Map showing Position of Mesopotamian Oil Occurrences.

oil occurrences have long been exploited in shallow hand-dug pits.

The region examined by Dr. Pascoe, and described in the memoir referred to, embraces the principal localities mentioned above, and gives that author's geological impressions in the form of fourteen reports, a summary report, and ten plates. Taken individually, these reports are necessarily somewhat local in character, often disjointed, and not easy to follow. On the other hand, the difficulties contended with during his reconnaissance, and passed over very modestly in the introduction, have to be recognized, and a decided value attaches to these field notes taken collectively as a basis of future detailed work in Mesopotamia.

With regard to the oil itself, the average product is of a dark blackish-green colour, highly viscous, of asphaltic base, and chiefly valuable as a fuel oil and as a source of kerosene (up to about 30%). It occurs in association with the gypsiferous beds of the Fars Series, that obtained from the overlying sandstones (presumably the Kurd Series) being probably a migrated oil. One of the best localities in the past has been that of Tel Kaiyara, where over 1,500 tons of crude oil per annum have been obtained. The Kirkuk district gives an annual yield of some 300 tons, and that of Tuz Khurmatu (Tushurmatu ?) about 700 tons per annum. Other occurrences, such as the seepages at Mandali, though at present commercially unimportant, are, none the less, promising. D'Arcy's original borings at Kend-i-Shirin (1903–4) brought in oil at 800 ft. in one case, and at 2,100 ft. in another. Wells are also reported to have been put down at Kufri.

Dealing with the economic future of the country in so far as petroleum is concerned, Dr. Pascoe says: "My opinion . . . is that the country will probably take a not unimportant place among the world's sources of petroleum. It should rival the Persian fields, and collectively outclass those of Burma." This important statement is followed by a classification of the actual

areas visited by that geologist with regard to their importance as districts likely to yield oil in remunerative quantity. Of the first importance he regards Qaiyarah (Kaiyara) and Quwair; Jabal Hamrin and Makhul near the Tigris, he regards as being of decided promise, while Kirkuk may be favourable for shallow-well exploration. Other areas are more speculative in his opinion, though a list of thirteen (excluding those mentioned) is given, many of the localities being quite new and chosen as a result of Dr. Pascoe's survey. The pitch and bitumen deposits of Hit (on the Euphrates) and Kaiyara also constitute natural resources of commercial value.

In conclusion, it must be admitted that the prospects of Mesopotamia as a future oilfield are distinctly favourable, but it is a case where theory must be put to exhaustive test. Not only are there questions of geological importance to be solved, but other factors such as government, native labour, accessibility, transport, and climate have to be considered. It is largely a matter of time, and of freeing commercial enterprise from political and international entanglements; this is essentially a case where a "dog-in-the-manger" policy will, if pursued, lead to disaster. If Mesopotamia is all that we hope and believe it to be in the matter of petroleum resources, ultimate development should proceed untrammelled by either national or international narrow-mindedness. It should be regarded, rather, as yet another source of that increasingly valuable fluid, natural petroleum, and not as a matter for political contention. The world is in undoubted need of new sources of oil fuel, and delay, either in developing potential resources known to us, as in Mesopotamia, or in exploring as yet unknown but likely areas in other countries, is neither politically nor economically justifiable.

BOOK REVIEWS

(1) **Coal Mining Costs.** By A. T. SHURICK. Cloth, octavo, 515 pages, illustrated. Price 25s. New York and London: McGraw-Hill Book Co.

(2) **Coal: Its Properties, Analysis, Classification, Geology, Extraction, Uses, and Distribution.** By ELWOOD S. MOORE, Professor of Geology and Mineralogy, and Dean of the School of Mines of the Pennsylvania State College. Cloth, octavo, 470 pages, illustrated. Price 25s. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

(1) It is decidedly unfortunate that there is nothing either in the title or on the title-page of the first-named book to indicate to mining engineers on this side of the Atlantic that the work is devoted entirely to a consideration and discussion of American methods, and that it is useless to the English colliery manager. Indeed, the ignorance of British methods displayed by the author is quite surprising; for example, it is well known that the general method of mining coal adopted in the United States is a system that somewhat resembles the Welsh stall method, with the stalls going off at an oblique angle from the main roads; Mr. Shurick as a change suggests what he appears to look upon as a new method, namely, dividing the property up into rectangular panels and working it into square pillars, and apparently has no conception that this is the method that has been used in this country for centuries. Again, British mining engineers will learn with some surprise that in the North of England the shafts "are usually lined with steel-tubbing." Elsewhere we find the statement that a "novel shaft-lining in the form of concrete blocks was used in a shaft in Belgium in 1912"; this same process is fully described in the *Transactions* of the Federated Institution of Mining Engineers for 1892 as having been used in various German collieries, and a British patent was taken out for it in 1891. As a matter of fact, concrete blocks for shaft-lining were described in England as far back as 1861. Evidently the author's novelty is at any rate half a century old in this country. The subject of haulage is very fully dealt with in the work before us, occupying no less than 145 pages out of a total of 502 pages, but by far the greater part of the discussion on haulage is given over to the electric locomotive; rope haulage is barely mentioned, and the author never appears to have heard of the important main-and-tail method. The only animal whose existence the author recognizes as used for animal haulage is the mule! The work is therefore of no use to anyone in this country except for the purpose of comparing American and British practice; even for the American engineer the work suffers from the grave defect that it is not up to date, and that no

attempt has been made to bring it up to date ; the author himself says in his preface " There has been no hesitancy, therefore, in using data of a number of years back so long as the subject discussed is still in general use," and suggests that there is no difficulty in converting these figures to suit prices of to-day. It need hardly be said that in this he is entirely wrong ; costs of wages and materials have by no means gone up in uniform proportion all round, wages having in some cases gone up more and in other cases less than materials, while it is a fact only too well known to colliery managers that the efficiency of labour has undergone a marked decrease within the last decade.

Such interest as the book may possess for the British reader lies in the fact that it occasionally enables comparisons to be made between American and British methods, though, as already hinted, these are for the most part ancient history and are not applicable to present-day conditions. For example, the author gives the United States statistics for the year 1912 in which the total production of bituminous coal was 450 million tons, which can be compared with the British figures got out by the Statistical Department of the Board of Trade for 1913, in which our output was about 287½ million tons. The figures given in both cases, converted into percentages, stand as follows :—

	United States of America (1912)		Great Britain (1913)
	%		%
Wages	74·1		72·7
Supplies	12·4	20·9	22·0
Salaries	5·4		
Miscellaneous expenses	5·1		
Royalty	3·0		5·3
	100·0		100·0

The pit-head cost of the American coal for the above year was $1·0538, say, 4s. 4·7d., whereas that of the British coal was 10s. 1·5d. Obviously we should be at a great disadvantage in the world's markets were it not that the American coalfields lie so much farther than our own from the seaboard and port of shipment. Necessarily the book brings out very clearly the far greater output efficiency of the American coal miner, as well as the much larger proportion of machine-mined coal, but this, again, is a well-worn subject, with which everyone in this country is only too familiar. There is, therefore, little more to be said at the conclusion than was said at the commencement, namely, that the value of this work to the British coal-mining engineer is exceedingly limited.

(2) The second of the two works covers most of the branches of the vast subject included under coal, as may be seen not only from the title but also from the contents, seeing that we have chapters on the physical and chemical properties of coal, on its chemical analysis, on its varieties and its classification, on its origin, on the fossil flora of the Carboniferous periods, on the structural features of coal seams, on prospecting, mining, preparation, and uses of coal, and finally several chapters devoted to its distribution. It is somewhat difficult to determine to what section of the community the author intends his work to appeal ; there is too much detail for the general reader, the section on the use of coal is far too superficial for the coal user, and the chapter on coal mining cannot be considered to be informative to the coal miner. Assuming, however, that there is a demand for information, such as this, on the subject of coal, Professor Moore's work may fairly be described as very good up to a point ; unfortunately the point is a very remote one. The serious drawback underlying the work is Professor Moore's extraordinary ignorance of all the recent work that has been done in this country, in which respect he even outdoes Mr. Shurick. To take one example, he gives a fairly full account of the microscopic study of coal, but in this he stops short at the work of E. C. Jeffrey, and never once mentions Lomax, and has apparently never even heard of the admirable work done by this worker, although his first work was published as far back as 1911 ; anything so modern as Dr. Hickling's paper on the Micro-Petrology of Coal, published in 1917, appears to be entirely beyond our author's ken. It seems incredible, but it appears to be true that Professor Moore has never heard of the *Transactions* of the Institution of Mining Engineers ; the first volume of these was published as far back as 1889, and the long series of *Transactions* published since that date are devoted almost exclusively to coal and coal mining in all its aspects, and it seems absurd that anyone should attempt to write seriously on coal without consulting *Transactions* of such monumental importance. Professor Moore appears to be ignorant of the greater part of our British literature with regard to coal. Anyone writing on this subject ought at least to be

aware of the fact that an important book on this subject has been published by Professor W. A. Bone, as well as several others; he apparently has never heard of the publications of our Fuel Research Board, nor of the well-known monograph on the Constituents of Coal, by Dr. Marie Stopes and Dr. R. V. Wheeler, published in 1918 by the Department of Scientific and Industrial Research. The result of his limited knowledge is naturally that he ignores a great deal of valuable modern research work. For instance, the recognition of the various constituents of coal, first systematized by Dr. Marie Stopes under the names of clarain, fusain, vitrain, and durain, is quite unknown to him, although modern literature is full of the importance of this classification; Professor Moore only seems to know the word "fusain" as the French equivalent of "mother of coal!"

One of the best chapters of the book is that on the fossil flora of the coal-forming periods, which gives a clear account of the different types of plants that entered into the formation of coal. The chapter on the mining of coal is tolerably elementary and might probably have been omitted with advantage. Minute accuracy in mining technology is, of course, not to be expected from a man who is essentially a geologist and mineralogist, but one might hope that he would have avoided so erroneous a statement with respect to longwall working as that "on the European Continent it is used almost entirely," seeing that nothing could well be further from the actual facts. The last chapter of the book, dealing with the distribution of coal, is nothing more than a summary of the Coal Resources of the World, published in 1913; the summary is quite a good one, but it might be expected that an author writing in 1922 should have taken advantage of the additional information published during the last nine years. Professor Moore has evidently never heard of the two volumes upon Coal and its By-Products, which form a part of the comprehensive series on the Mineral Industry of the British Empire and Foreign Countries, published by the Imperial Mineral Resources Bureau.

There is little need to discuss this book in detail; enough has been said to show that it labours under deficiencies of a very grave order, and that it is hardly a volume to be consulted by anyone who desires up-to-date information on the subject of coal.

It would be foolish as well as ungracious to minimize in any way the value of America's contribution to our knowledge of coal and to the literature of the subject, but at the same time it must be recognized that inevitably all that has been produced in America is only a fraction of what has been done in Britain, where the coal industry dates back to a far more remote period, and it is hopeless for anyone to attempt to write a comprehensive account of coal unless he takes the trouble to study thoroughly the British literature of the subject. If Professor Moore would do this and then re-write his book, he would no doubt produce a volume of real worth.

HENRY LOUIS.

The Mineral Resources of Burma. By N. M. PENZER, M.A. Cloth, octavo, 336 pages, with 6 maps. Price 31s. 6d. London: George Routledge & Sons, Ltd.

After writing his compilation on the Tin Resources of the Empire, Mr. Penzer has selected Burma for his next effort in providing useful information for the British public. By so doing he has no doubt earned the gratitude of many, particularly of the people and officials of Burma, for his book obviously fills a gap. But there are many defects in the book. The most obvious shortcoming is that it might have been brought up to date. The mineral reports are three years old, and the census figures for 1921 could have been given instead of those of 1911. There are other matters which an expert could put in their due proportions. For example, Mr. Penzer goes into great detail over the salt sales, etc., but says remarkably little about coal. He does not appear to know that the Ruby Mines are a district in Burma, and has omitted to mark the coal-fields on his mineral map, while he has inserted numerous occurrences of minerals which are not of commanding interest. Much more could have been said of the roads, railways, etc., which are being surveyed or are in progress of construction. A chapter might have been devoted to the question of labour for industrial purposes. However, it is easy enough to pick holes in a compilation which is admittedly not the work of a mining engineer. From the point of view of the interests of the Empire, the object of this book is to be commended. The various opinions which will be expressed in reviews on this book will give Mr. Penzer the guiding lines for a second, more up-to-date, and

somewhat better presented work on one of the richest provinces of India.

CYRIL S. FOX.

☞Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, London, E.C.2.

NEWS LETTERS

TORONTO

July 10.

PORCUPINE.—The gold-mining industry continues very active, the leading mines steadily increasing their output. At the annual meeting of the Dome Mines on June 13, it was announced that the yearly dividend would be increased from $1 to $2 per share, and that the policy of making repayments on capital would be continued. General Manager H. P. De Pencier reported that ore from the 11th level assayed $20 per ton. The mine had been worked down to a depth of 1,150 ft., and so far $15,000,000 in gold had been extracted. A shaft had been sunk 450 ft. farther and investigation showed no change in the formation at this depth. During June the value of the gold recovered was $351,531, the total value of the output for the first six months of the year being approximately £1,974,482.

The production of the McIntyre-Porcupine for the year ended June 30 was estimated approximately at $1,900,000, making its total production since operations were begun about $11,035,564. The company paid dividends to the amount of $546,042 during the year. The mine has been opened up to a depth of 1,875 ft., proving the downward continuation of large ore-bodies. One important deposit which was expected to cross the boundary and pass into the adjoining Hollinger property has taken a turn and remains in the McIntyre. The new milling units, increasing the capacity by 50%, is just going into operation.

The Hollinger Consolidated has secured an option on the Schumacher mine at a purchase price of $1,650,000, of which a sum of $165,000 has already been paid. The transaction has been ratified by the Schumacher shareholders. The Schumacher property, which adjoins the Hollinger, comprises about 160 acres, and has been closed down for four years.

The Rochester property, adjacent to the Hollinger on the north, has been taken over by a new company, the Canadian Gold Mines, Ltd., in which American financiers are largely interested, for $275,000. Diamond-drilling and shaft-sinking will shortly be undertaken. The West Dome and Dome Lake companies have been merged in a new company, entitled the West Dome Lake Gold Mines, capitalized at $5,000,000. Each of the constituent companies will receive 1,500,000 shares, and after allotments as bonus to the underwriters and to meet outstanding bond issues 1,450,000 shares will remain in the treasury. At the Goldale sinking operations are actively under way. Lateral work will not be undertaken until the 500 ft. level is reached.

KIRKLAND LAKE.—The Kirkland Lake gold area has made rapid progress this season, and though its output is now much below that of Porcupine, promises to become a formidable rival to that field in the near future. It has more individual producing mines and a greater number of properties in the development stage than any other Canadian gold district. The Lake Shore during May produced gold to the value of $40,834 from the treatment of 2,212 tons of ore averaging $1,848 per ton. Dividends, which hitherto have been paid irregularly, have been placed on a basis of 8% per annum. The directors are planning to enlarge the mill, the present capacity of which is 50 tons per day. The work of enlarging the main shaft will be proceeded with at once with a view to developing the downward continuation of the ore-bodies at a depth of 800 ft. At the Teck-Hughes, recent development has proved the occurrence of rich ore at the lower levels. The installation of a 1,000 ft. hoist, electrically driven, has been completed at the 500 ft. level, which will enable operations to be carried on to a depth of 1,500 ft., which is expected greatly to increase production. Work on the Tough-Oakes and Burnside properties of the Kirkland Lake Proprietary is producing good results, the most important development being the discovery of the continuation of the "main break," which after being faulted a limited distance, apparently continues through the full breadth of the property. The mill is treating from 60 to 70 tons of ore daily. The Wright-Hargreaves has made a rich strike in a stope at a depth of 400 ft. Good ore has been taken out in development work, but an ore-shoot encountered is stated to surpass in richness anything previously found, containing native gold in profusion and heavy gold tellurides. The mill has been handling about 200 tons

daily. At the Bidgood, the shaft which is being sunk to the 600 ft. level has reached a depth of 450 ft. The ore has been found to show improvement at depth. Development is in progress at the Munro-Kirkland, which has been taken over by the Thompson interests of New York, and on the Bryce group of claims in the central part of Lebel Township.

COBALT.—According to preliminary estimates the silver mines of Cobalt, South Lorrain, and Gowganda districts produced approximately 800,000 of silver during June, showing an increase over the May output. The resumption of operations by the Dominion Reduction Co., which is treating the sand tailings from Peterson Lake, will further increase the output this month. The silver content of these tailings is low, but by handling a tonnage of about 350 tons daily a margin of profit can probably be realized. The mill of the McKinley-Darragh is treating an average of about 125 tons of ore daily, and costs have been substantially reduced. The shaft on the Victory has reached a depth of 475 ft., where cross-cutting will be carried on to tap promising veins encountered on the upper levels. The Colonial mine has been taken over by New York interests. The shaft will be put down to the 900 ft. level in the expectation of striking the continuation of a vein which has yielded considerable high-grade ore on the O'Brien property adjoining. The Nipissing during May produced ore of an estimated net value of $197,715, and shipped bullion of an estimated net value of $250,750.

MATACHEWAN.—Very little work is being done in this camp pending the development of electric power and better transport facilities. The Matachewan Power Co. has undertaken to supply the former requisite, and a force of 100 men is now at work on power development at Indian Chute on the Montreal River, about 16 miles from Matachewan. Some 5,000 h.p. can be generated at this point, and it is expected that 2,000 h.p. can be produced by the equipment now being installed. Delivery of power is anticipated before the end of the year. American financiers are taking a keen interest in the project, the completion of which will be the signal for a renewal of activity in this promising field.

VANCOUVER, B.C.

July 11.

THE NORTH-WEST MINING CONVENTION, which was held at Nelson, B.C., on June 3 and four following days, was well attended by delegates from all parts of the North-West and as far south as Los Angeles. A number of excellent papers were read, the staff at the Trail smelter contributing liberally in this direction. Probably the most noteworthy feature of the convention and one that is likely to be far-reaching in its effect was the announcement by S. G. Blaylock, managing director of the Consolidated Mining & Smelting Company, that malleable iron had been made from the tailing of the Sullivan mine ore in the company's laboratory. Sullivan mine ore, it may be well to remind the reader, is a compact sulphide composed essentially of galena, zinc-blende, marmatite, pyrrhotite, with a little pyrite and about 6% of gangue, or earthy matter. I added "earthy matter" because Mr. Blaylock referred to the pyrrhotite as gangue, which is a nice point for the precise technologist. About half of the ore is pyrrhotite, and at the present time flows away with the tailing into the Columbia River. When the new concentrator, the first unit of which is now in course of construction at Kimberley, is finished it will treat 1,500 tons of Sullivan ore per day, of which from 400 to 450 tons will consist of iron in the form of pyrrhotite. If in future this can be saved and the metallic iron be reduced in a marketable form it will be a splendid thing not only for the Consolidated Company but for the whole Province, which at the present time has no iron or steel industry. No details of the process were given, Mr. Blaylock contenting himself by announcing that soft iron had been made by an electrolytic process in the laboratory, and that the iron produced could be rolled to a thickness of one-thousandth of an inch and then be folded backwards and forwards fifty times without breaking. It is true, of course, that it is only a laboratory achievement at present, but those who have followed Mr. Blaylock's announcements will have noticed that he is not prone to make a public statement of this nature unless he has reason to believe that there is something of commercial importance behind the laboratory experiments.

L. H. Biggar, manager of the Ottawa mine, read an important paper on the application of flotation to old mine-refuse in the Slocan. Six months operation of a 30 ton

plant has resulted in the saving of more than $30,000 worth of silver from the Ottawa mine waste-dumps. The material handled was a dry silver ore, containing neither lead nor zinc, and averaging 9·8 oz. in silver per ton. The cost of reclamation, tramming, milling, freight, and smelter charges amounted to only $2·20 per ton. There is much ore on the waste dumps of abandoned and operating mines in the Kootenays that might be treated by flotation, but perhaps the more important lesson to be learned from Mr. Biggar's paper is that a flotation plant is a necessary adjunct to a shipping mine, for then material of the nature that Mr. Biggar has been treating would never find its way to the waste dumps.

Northern British Columbia.—The north-western part of the Province continues to maintain its splendid record. The Premier Gold Mining Company has lowered another record by declaring a dividend to 15% on its capital of five million dollars for the quarter ended June 30, bringing the total disbursements since December 31, 1921, when the company paid its first dividend, up to $1,650,000.

C. A. Banks, consulting engineer for the B.C. Silver Mines, Ltd., has returned from England, and is superintending the exploration and development of the company's claims, which adjoin those of the Premier company. No information is yet to hand as to any possible deal between the Premier and the B.C. Silver Mines.

Pat Daly and associates, who have bonded the New Alaska and other properties, are developing some promising ore-bodies on the surface at the New Alaska. This property, consisting of 15 claims, is situated on both sides of the international boundary, and the road to the Premier mine passes through it.

George Wingfield, of Reno, Nevada, who holds a mortgage on the Dolly Varden and Wolf mines, the Dolly Varden-Alice Arm railway, and all the rolling stock of the railway and the equipment at the mines and at the wharf at Alice Arm, has obtained a Court order for an accounting prior to an order for foreclosure. It is rumoured that Mr. Wingfield has reached an agreement with the Taylor Mining Company, which owns the mine, whereby the latter may re-obtain possession of the properties by liquidating the debt and paying the legal costs within a given time. The fact that the order of the Court was unopposed lends colour to this rumour. In the meantime, the Provincial Government is repairing the railway sufficiently to allow hand cars to be run along it, and thus allow prospectors who have properties along the line and at the head of the Kitsault valley to take supplies to their claims, the understanding being that whoever ultimately comes into possession of the railway will reimburse the Government for the outlay it is making in repairing the line.

The Silverado Mining Company, which has developed a 16 in. vein on the mountain across the Bear River from the town of Stewart and has made several shipments of ore running about $600 per ton, has closed down, pending, it is understood, the financing of a better transportation system.

A. B. Trites and associates have started exploration work on the Big Missouri. The camp that was built by the previous holders of an option has fallen into disrepair while the property has been abandoned, and a new and better camp will have to be built if development work is to be continued through next winter.

Two promising new ore-bodies have been found above the old workings at the Esperanza mine, near Alice Arm. The mine has been shipping ore to Anyox steadily for some time, and there is every prospect of its continuing to do so.

Southern British Columbia.—The Hedley Gold Mining Company, which reopened its Nickel Plate mine early in the spring, has started its 40-stamp mill. With a view to producing as much gold as possible during the war, the company concentrated all its energies on production and allowed development to fall behind, thinking to catch up at the close of the war. The high prices of labour and supplies that followed the armistice prevented this, and in October, 1920, the mine had to close. The Nickel Plate has been one of the best gold-producing mines in the Province, at one time contributing from one-fifth to one-quarter of the gold production, besides considerable quantities of arsenic. The ore-body is large and averages from $8 to $10 per ton in gold. The company will spend $30,000 on diamond-drilling with a view to finding the extent of the ore-body.

The Liberator Gold Mining Company has started its new mill and cyanide plant at the Emancipation mine, near Hope, on the Kettle Valley railway. The mine is conveniently situated, the mill being close to the railway, and some promising ore-bodies

have been opened. E. T. Hodge, formerly Professor of mining geology at the University of British Columbia and now holding a similar position to the University of Oregon, is consulting engineer for the company and will spend his summer vacation at the mine.

Another shipment of bonanza ore has been made from the I.X.L. mine, near Rossland. The ore-shoot, which was lost for a time, has been regained, and is said to be as rich as ever. The mine is leased by former employees of the Consolidated company, who have cleaned up more than $30,000 worth of gold in the last year. The good fortune of these men has started an epidemic of prospecting in the district.

The Consolidated Mining & Smelting Co. has re-started work at its Rock Candy mine and mill, at Lynch Creek, in the Grand Forks division. The mine was closed early in 1921, there being no market for the output. In 1920 the mine produced 7,500 tons of fluorspar concentrate, most of which was purchased by the iron and steel plants at Gary, Indiana. It is understood that the Consolidated company has a contract that will keep the mine in operation for the next twelve months.

Several new discoveries are reported from the Kootenays, the most important of which is the opening up of a 5 ft. vein assaying 58% of zinc at the Whitewater mine, at Retallick. This is one of the richest zinc strikes that has been made in the Province. A 5 ft. vein assaying $200 per ton in silver and lead has been struck at the Mineral King group, near Windermere, East Kootenay.

BRISBANE

June 5.

MOUNT ELLIOTT CAPITAL.—The news lately received from London that a hitch has occurred in connexion with the expected £360,000 additional capital for the Mount Elliott Company, operating in the Cloncurry district, has caused great disappointment here. The bulk, if not the whole, of the shares of this company are held in Great Britain and France, and four months ago the cables announced that arrangements had been made to raise the sum named in about equal parts in these two countries. The news now received is to the effect that the support promised by the French group of capitalists is not forthcoming, and that the matter is consequently again hung up. The French shareholders are slightly in excess of the English, so that the ultimate word is with the French. Probably adverse exchange prevents the French from participating in English ventures at present. The company, of course, has not given up hopes of still raising the capital, under more propitious circumstances, which is needed to carry out the big scheme in connexion with their Cloncurry mines.

The Mount Elliott Company closed down its smelters and mines at the end of March, 1919, and since then no work has been done except some development operations at the rich Mount Oxide mine, which is in the extreme north-western end of the Cloncurry field, and which the company acquired from the now defunct Mount Oxide Company. In the short campaign of 1919, the Mount Elliott Company claimed to have demonstrated that their 4% ores were payable and had proved profitable in actual practice. Subsequently Mr. Edwin S. Berry, who inspected and reported on the company's mines on behalf of a New York firm, estimated that, calculating on the basis that no ore of less than 5% should be taken into account, a profit of £556,000 could be made ; but the American capital that was expected to be made available as the result of this report was not forthcoming. Mr. W. H. Corbould, consulting engineer and general representative of the Mount Elliott Company, in 1920 submitted to his directors a method of his own for the treatment of the company's low-grade ores, involving the erection of central works in the Cloncurry district and the construction of a railway from Dobbyn (the present terminus of the railway from Cloncurry to Mount Cuthbert) to Mount Oxide, a distance of about 80 miles. Mr. Corbould estimated the ore reserves of the company at 1,876,000 tons, with an average grade of 4·63%. He was convinced that, by the carrying out of his scheme, and with copper at £80 per ton, the 3% ores of the company's group of mines could be made profitable, and was satisfied that, with a working capital of £520,000, a profit of £2,000,000 could be made available from tonnages of ore which he knew to exist, and without considering " good possibilities of several millions of tons to follow as development work is extended." This estimate of required expenditure did not include the construction of the Mount Oxide railway, which is expected to cost £300,000 ; while it has, of course, to be remembered that at the present time the

price of copper is a long way below £80 per ton. While the Mount Elliott Company was in full work in the earlier days of their operations, it paid dividends amounting to £2 7s. 6d. per share on their 237,518 £5 shares, or a total of £564,105, the last dividend having been paid in December, 1913.

MOUNT MORGAN. — Since resuming operations towards the end of March, after nearly a year's idleness, the Mount Morgan Company has published two four-weekly returns. During these two periods the total production was 806 tons of copper and 9,655 oz. of gold. In the corresponding eight weeks of 1921, the production of the mine was 951 tons of copper and 13,273 oz. of gold. In view of the number of unemployed in the State—and receiving Government aid—it is a surprise to learn that the smallness of the last returns is ascribed to a scarcity of competent miners. The township of Mount Morgan is reported to be still suffering from depression, and the fact appears to be that the late employees themselves have not confidence in the ability of the company to carry on for any length of time under the conditions which the miners have insisted on. The accountants who specially reported on the affairs of the company in May last year showed that with the then ruling price of electrolytic copper (£74 per ton), and with the reduction of 20% in wages asked for, operations could not be resumed except at a loss. With the aid of a weekly subsidy of £1,100 from the Government the proposed 20% reduction in expenses has been obtained, although the employees are actually only suffering a loss of between 5 to 8%; but copper quotations are now about £9 per ton lower than in May, 1921. The company expected to effect some saving by getting coal from a mine of their own lately opened up at Baralaba, but, so far, only a small proportion of the total consumption is obtainable from this source. To the outsider it looks as though only an increase in the market value of copper could enable them to carry on for long, and there are just now some indications that a change for the better in this respect is taking place.

COBALT AT CLONCURRY.—The cobalt mine at Mount Cobalt, in the Cloncurry district, was taken in hand by the present owners, the principal of whom are, or have been, connected with the Mount Elliott Company, in 1920. Up to the end of last year 500 tons of ore had been shipped to England, but it is reported that up to that time the whole of this had not been sold. The annual report of the Mines Department for the year shows a return of 83 tons of cobalt, valued at £21,332. During this year up to the present another 150 tons has been despatched to England. The property, which is the only cobalt mine now being worked in Queensland, is a large and rich deposit, and if a regular and satisfactory market can be obtained for the product, it should prove a very profitable concern. It is stated that such a market can be reckoned on as soon as it is shown that a regular supply of cobalt can be assured. At present a crushing and concentrating plant is being erected at the mine, and only a limited amount of mining is being carried on pending its completion, which is expected about the end of the present month.

PERTH, W.A.

June 24.

LABOUR AND WAGES.—The long-looked-for award of the Arbitration Court on the wages at Kalgoorlie has been given, but the only relief granted to the mine owners is 1s. per day all round, and no penalty rate for Sunday work on continuous processes. The reduction is insufficient to save the mines. The previous increase was not only 3s. 6d. per day, but also a fortnight's holiday per annum on full pay, and several other concessions which increased costs very considerably. While the gold premium was high this increase could be met, but now that gold is rapidly declining to normal, several of the big labour-employing mines will have to shut down. Others will have to increase the grade of the ore treated, and thereby rapidly hasten the end of the mine. Hitherto the farmers and timber-mills have been able to absorb most of the surplus labour from the mines, but now the latter are very slack, and the farmers are frightened to go in for clearing operations on new ground until they see how much the price of wheat is likely to fall. This excess of labour available will mean a greater efficiency of those employed. This is a much more important factor than the wage question, as since 1914 the efficiency per man has decreased considerably.

PROSPECTING EXPEDITIONS.—The impetus given to prospecting by the sending out of the big expedition by the Mines Department, under the leadership of Captain J. W. Jones, R.E., has caused several parties to

prospect new country. If the success of the ventures depend upon the type of prospector, it should be assured. The notice calling for applicants for the Government party brought men in from various centres, who had drifted into other avocations. Some of these old prospectors, although they were not fit enough for the big expedition, have been equipped by the Mines Department with camels and provided substance to allow them to get out and prospect the country between the Gascoyne and Ashburton Rivers, in the north-west, which contains both base metal and gold ores. It can be safely said that there are more sound prospectors out at the present time in this State than for many years.

The Minister for Mines has agreed with the contention of the Prospecting Board that there should be some technical supervision over their work. This point has always been emphasized by the writer of these notes, but it has taken years to convince the Minister for Mines to that effect. He now agrees to appoint a special Inspector who can keep moving around and acting as an adviser to the prospectors ; and this will mean a report on their work by him to the Prospecting Board, in order to eliminate the men who will not do good work.

Dry-Blowing. — The "Bligh" dry-blower, which is a petrol-driven machine, has been proved to be a success on old alluvial tailing heaps. The patentee is making something like £50 per month clear profit on 1 dwt. alluvial tailing, and the Mines Department has given an order for two machines to be tried on other fields as an object lesson. The Department will grant a lease of 24 acres of old alluvial ground to anyone who puts up a machine ; and it is quite possible that many of the old surface alluvial workings will be gone over again. The machine, including the engine, will cost about £250, and can be transported with one horse. The procedure is to set up the machine and work the ground around for a distance suitable for bringing in the tailing with a horse scoop, picking up a scoopful of treated tailing on the return journey and dumping it.

Hampton Plains.—At Hampton Plains the Celebration Company's treatment plant is now running satisfactorily ; the difficulties which have to be overcome in adapting a process to a new ore take time. The continuous decantation plants hitherto working in this State have been on roasted ore or quartz slime, whereas the kaolinitic oxidized ore on the Celeb ration is more difficult to settle, which means a larger vat area than with a roasted ore.

The ten-head mill on the White Hope mine is nearing completion, and it is expected to be running early in July. Although the ore is sulphide, the trial crushings at the Hannan's Central Battery, Kalgoorlie, show that a fair extraction can be obtained by amalgamation and direct cyanidation, provided aeration is secured by turning over the sand in the vat during treatment.

The Golden Hope Company has put in an air-compressor, and progress will be much faster now. There has been a gradual improvement in the value of the ore as the lode was driven on north, and the last fortnight's average was 80s. over the width of the drive, 50 in., while there was ore still in the wall.

On the Hampton Properties, Ltd., Location No. 45, water has been cut in the new main shaft at a depth of 150 ft., and winding and compressing plant is being erected. The workings on the main lode have been connected at the 100 ft. level with the new main shaft, and the stripping of the lode at that level as far as it has gone confirms the original estimates as to width and value, which can be taken as 12½ dwt. to the ton over 10 ft. in width. The ore is still oxidized at the 150 ft. level, but it will probably change to sulphide below water-level. There are not any porphyry intrusions on this line of lode. The lode has now been cut at various points for over half a mile in length, in which shoots of ore occur in payable lengths.

Oil Prospecting.—The boring work which is being carried out by the Freney Oil Company, near Mount Wynne, some 95 miles south-west from Derby, has been started under the supervision of Mr. Torrington Blatchford, Assistant Government Geologist, who has been lent to the above company for a year. The Government will be supplied with all geological data obtained by Mr. Blatchford and his assistant, Mr. H. W. Talbot, late of the Geological Survey.

Mr. Maloney, M.Sc., F.G.S., a member of the Victorian Geological Survey, who was lent to the Okes Durack Company to report on their area, stated on his return that, while he could not commit himself, he was very pleased at the results of his observations. He stated that indications in the form of bitumen occur, which is very remarkable, while the structure of the beds is conducive

to the retention of oil. The formation associated with bitumen covers a very extensive area. He emphasized that only by boring could the existence of oil be proved, but as far as geological data went the outlook is most favourable, and there is every reason to justify boring operations and for high hopes of success. The age of rocks in which the bitumen occurs is much greater than that of the rocks prevalent in the oilfields of Java and Borneo, and corresponds more nearly with the oil-bearing rocks in the central and eastern states of the United States of America.

Mr. Maloney laid out the sites for boring, and the work will be carried on by the manager of the company, who is a petroleum engineer.

There are several other parties in charge of geologists, mapping and reporting on the northern and nor'western portions of this State, and as each party is accompanied by some gold prospectors there is quite a possibility of a good discovery being made by one or other of them.

COPPER LEACHING.—Most interesting experimental work has been carried out here recently on the leaching of low-grade copper ore. The process evolved by Mr. Sleeman for the Whim Well mine provides for the leaching of the ore, after being crushed coarsely, by means of a solution of iron salts, which, after passing through heaps of the oxidized copper ore, are circulated through beds of pyrite, whereby the solutions are rejuvenated, thus reducing the costs very considerably.

The Australian Minerals Recovery process is somewhat similar to the Webster process, referred to in the April number of the MAGAZINE. In the local process the solvent is ferrous sulphate and salt; and while using the fine iron as a precipitant at the same time, similar to the method used in the Webster process, the Minerals Recovery Co. propose to heat the pulp to 70° centigrade in order to accelerate the action.

It is hoped that one or both of these local processes will prove to be a commercial success, as there are great quantities of ore in this State which will not pay to send to smelters, but should be very profitable if they could be treated on the mine. Hitherto ore varying from 10 to 30% of copper has been picked and shipped, leaving dumps of ore assaying 2 to 5% for which there was no immediate treatment suitable.

[Details of the Australian Minerals Recovery Co.'s process are given elsewhere in this issue by one of the inventors, Mr. P. H. Nevill. Mr. Sleeman described his process in the MAGAZINE for July. An error of reference in the July issue may be made here. It was stated, in an interpolation in Mr. J. D. Audley Smith's letter on the Pechey copper leaching process, that Mr. Smith's paper in *Chemical Engineering and Mining Review* was reproduced in the current (July) issue of the MAGAZINE. As a matter of fact it was reproduced in the previous (June) issue.—EDITOR.]

SOUTH AFRICA

July 11

INDUSTRY BOARD AND MINING ECONOMICS.—The proceedings of the Mining Industry Board are never so amusing as when we find intricate technical questions discussed by enthusiastic laymen. This situation was well revealed when Mr. W. Brace, on the Board, and Mr. Sheridan, a representative witness of the South African Mine Workers' Union, began to discuss working cost calculations and underground sorting. Mr. Sheridan's first contention was that costs should be calculated "per ounce" instead of "per ton." There is no need to recall the numerous occasions, ancient and modern, upon which the tonnage unit has been assailed, nor upon which some unit, better reflective of profits, has been proposed. It is, however, strangely illustrative of the educational influence of recent strike literature and propaganda that a Labour representative should advocate the calculation of costs per ounce of gold when it was this one unit of cost (against the ever falling value per ounce) that the mining companies used consistently in their efforts to awaken the public and politicians to the seriousness of the situation before and during the strike. The Rand controls have always appreciated the units "cost per ounce," as they have studied the "profit per month" and "profit per claim." But for everyday use in the hands of the normally conscientious manager, who does not send waste to the mill that can be profitably excluded, there will never be a more serviceable and instructive unit until the metric system is adopted.

With regard to the suggestion of underground sorting and Mr. Brace's favourable comments, in his vain belief that increased sorting means an increased demand for white labour, it is difficult to discuss the

matter without an opening lecture on elementary Rand mining practice. It may be categorically stated that the question of "how much waste can be sorted underground and how much on surface" has been a matter for constant thought, followed by constant practice, in every Rand mine for over twenty years. The problem has been one of degree and the logical opponents of close sorting could only be those people who wish to see Rand gold expended in wages and stores rather than distributed in dividends.

Rand Working Costs.—In twelve years the Rand has passed through an economic cycle. At the beginning of this period, when the call for maximum profit per ton or per claim was heard, the previous objective of low costs was roundly condemned. Wild reports were circulated of excessive waste rock milled and of sorting, in mine or on the belts, deliberately scamped. Rapidly the policy of forcing grade developed, and the increasing burdens placed on the industry, by Government and Labour, drove out all remaining ambitions toward the utilization of the poorer ore. The crash came and, after it, the inevitable return of a conservative low-cost policy. The mines have still a difficult task ahead of them to bring their costs to within 2s. 6d. per ton of 1910 figures. Nevertheless, since the strike, creditable progress has been made on several mines. Working cost comparisons cannot be too closely made without records of development, necessarily curtailed with the native labour deficiency. A few cost comparisons of cost per ton are instructive:—

	Dec., 1921		June, 1922	
	s.	d.	s.	d.
Crown Mines	23	1	23	0
City Deep	28	7	26	6
E. R. P. Mines	23	5	22	10
Government Areas	20	10	18	7
Meyer and Charlton	25	3	23	9
Modder B	27	5	22	2
New Modderfontein	21	6	18	6
Rose Deep	22	1	19	10
Van Ryn Deep	25	2	22	1
Witwatersrand	21	7	20	3

The 1921 working costs of 25s. 8d. per ton placed the district on a suicidally selective basis. A clamour for low costs (the pre-war 18s. 6d., plus 2s. 6d.) must continue until the "lost millions," that is, the "unpayable tonnage" in low-grade mines and low-grade sections of rich mines, are restored to the industry.

Mining Finance and a Turf Lottery.—At one time the New Southern Van Ryn Deep G.M. Co., Ltd., attempted to take itself seriously and succeeded in making a portion of the public ready to support independent enterprise, believe in the soundness of its schemes and declarations. This time has surely passed, and we find a concern, bearing within its title the honoured name of Van Ryn, utilizing its organization for the conducting of a turf lottery. Advertisements, appearing throughout the country, announce that 400,000 fully paid shares are offered at par (2s. 6d.). With every parcel of four shares (10s.) is given the right to submit one set of predictions for the winning horses of the Durban July Handicap. A prize of £7,500 is offered for the correct placing of first, second, third, and fourth horses (out of twenty-two nominations), a prize of £4,500 for first, second, and third, of £2,000 for first and second, and £1,000 for first and third place. The absurd ratios between prizes, bearing no relation to the gambling chances for each prediction, indicates the lack of mathematical soundness in the scheme even from the lottery standpoint. Considering the third offer (£2,000 for first and second horses), a "bet" is purchasable for 10s., and the odds against thus represent 4,000 to 1, a daring bit of book-making, unless the first guess opened is to be the only prizewinner. The company's advertisement states "£15,000 to be distributed free to shareholders in a famous Far East Rand mine," which signifies that only one correct guess under each head is to be rewarded. Eliminating the first chance, we find therefore that the offer boils down to the return of £7,500 out of £50,000 subscribed, while the balance is devoted to advertising expenses, to commissions, and to the continuance of mining operations in a concern of which no technical, financial, or personal details are given.

Minerals Deposited in Mine Pipes by Bacteria.—A remarkable occurrence of the rapid deposition of mineral in a mine pipe, of wide scientific interest, has been described by Mr. J. Parry, of the De Beers Laboratory, in a lecture given before the Diamond Fields Mining Institute. At a depth of 2,000 ft. in one of the mines, idle for ten years, a vertical 6 in. iron pipe, 180 ft. long, became largely filled with a hard, brittle, and fibrous mineral, amounting to 3½ tons in quantity. The mineral was found to be carbonate of lime, coloured brown by organic matter

derived from shaft timber. But the cause of this rapid precipitation from water yielding only five parts of calcium carbonate per 100,000, and where evaporation was necessarily a negligible factor, could not be surmised. Later laboratory investigations showed that the mine water was crowded with micrococci and bacilli, each surrounded with a transparent gelatinous envelope, micro-organisms found capable of withdrawing calcium carbonate from solution and building it up into its own tissues unaltered. In the mine, these bacilli adhered to the pipe, as in the laboratory they adhered, with their sticky, gelatinous jackets, to the sample bottles, forming a greyish white deposit, without evaporation, without loss of carbon dioxide, without any chemical precipitating agent, and without any increase of temperature. Five years ago the late Dr. Drew investigated the effects of a bacillus found in the surface waters at Jamaica, which he contended caused the precipitation of calcium carbonate on a large scale. Dr. F. E. Wright, of the Carnegie Institution of Washington, who performed some of Dr. Drew's laboratory work, was present at Mr. Parry's lecture, and emphasized the probable importance, in this field of research, of the new evidence presented by the phenomena in the De Beers mine pipe.

South African Silver-Lead.—Great interest attaches locally to the exploratory work of the Pretoria Silver Company in the Pretoria district, for the reason that so little success has been achieved by silver-lead producers in South Africa in the past. Representing a genuine effort to open up the most promising prospect known to-day, the venture has gained good support. To continue development and construction, £30,000 of mortgage debentures are now being offered to shareholders. In their statement the directors give the tonnage developed at 7,700 tons, and contents at 15 oz. silver and 15% lead. Viewed in comparison with mines of this class in America and Australia, the Pretoria mine is, indeed, a small thing. If it fails there will be no fiasco. If it succeeds the company will deserve all the profits it can win.

Mining Regulations.—The gold mines of the Rand are the most heavily regulated concerns in the world. The voluminous regulations, studied and forgotten by every candidate for examination, are a cause of amazement to newcomers from other mining fields, where unwritten laws of humanity or self-preservation cover effectively the same ground as many legally-phrased enactments under Transvaal or Union Law. Sir Evelyn Wallers has attacked the regulations before the Industry Board. New arguments were unnecessary. The regulations are too voluminous and the vitally important provisions are obscured by a host of "musts and mustn'ts" of trifling significance. The Government's point of view is understood to be that these detailed regulations are necessary in the Transvaal because 90% of the employees are natives, requiring special protection from themselves or from callous bosses, and this contention represents 90% of the case for the regulations, but not all. South African Inspectors of Mines are not lawyers, but are practical men with a good knowledge of the unavoidable risks and irregularities of mining. They soon get to know the mine managers, mine captains, and shift-bosses in their district. They know who are careless, who indifferent, who take excessive chances, and who may have peculiar difficulties to contend with or a stroke of bad luck. It may be said that the inspectors simply utilize two-thirds of the regulations as a means of punishing and correcting the persistently careless boss or man. The efficient inspector—and most of them come under this head—does not go through the mine to search for a maximum number of instances of broken regulations, even though he may be quite familiar with the official volume. He looks for negligence and carelessness, and if accidents in illustration are frequent, he seeks (and surely finds) a law under which to charge and punish the offender.

Gold in South-west African Protectorate.—Wild reports based on an interview with a member of the C.I.D. in the South-West African Protectorate, have been published in Johannesburg with regard to a wonderful gold discovery in the region of Keetmanshoop. In the first reports (which have drawn many investigators and peggers to the district) the chief features were claimed to be: (1) Vein of magnitude and continuity of the Rand beds; (2) gold assays averaging ounces to the ton; and (3) same line of latitude as Johannesburg. With the exception of this last geographical characteristic, which remains uncontradicted, reports have been mostly unfavourable. There are certainly no facts to hand at present to indicate any importance in the discovery.

KUALA LUMPUR, F.M.S.

July 1.

MINING DURING 1921.—The report of the Mines Department of the Federated Malay States for the year 1921 has just been published and chronicles diminished activity in tin-mining operations. This diminished activity might have been expected to seriously affect the output of tin. In this respect, however, those who are cognizant of the conditions under which mining is carried on in Malaya will not be greatly surprised to find that the figures of production are not much less than those for 1920, since it is not unusual to find that in this country, where the greater proportion of the tin is produced in Chinese mines, a low price for the metal does not necessarily result in a diminished output, but frequently is the cause of an increase in the amount of tin won.

There was a decrease in the land alienated for tin mining as compared with the year 1920 of 15,800 acres ; a decrease in the labour employed in mining of 3,218 or 3·7%, which was not such a decrease as might have been expected; a decrease of 5,160 h.p. in machinery and hydraulic appliances. The strictest supervision was exercised over the control of tailings in view of the increasing deterioration of rivers through the flow of silt. There was a considerable decrease in the number of licences taken out by ore-buyers. The result of the year's working was that the amount of tin exported was 34,490 tons in 1921 as compared with 34,935 tons in 1920, a decrease of only 445 tons. It is reasonable to expect that if low prices for the metal should continue for much longer the output will be more seriously affected, but the fact that a drop in the average price of the metal from over £297 a ton in 1920 to £168 a ton in 1921 resulted in a diminution of the exports by less than 500 tons is rather remarkable. The explanation is that the Chinese mining labourer has simply adapted himself to the circumstances. About 13,000 labourers were discharged from the larger mines, but they were absorbed elsewhere. Wages fell considerably, and in many cases labourers worked for their board alone. There was a decrease in contract labour of 30·7% and an increase in tribute labour of 49·86%, compared with 1920. This is the explanation of the maintenance of the output of tin in Malaya, and it indicates the stoicism of the Chinese mining labourer. After the experience that Malaya has gone through during the last two years, fears which were felt by some as to the probability of serious trouble among the Chinese miners may be set at rest.

The Federated Malay States rely to a considerable extent on tin for their revenue. This has suffered very seriously lately, owing to the fall in the price of the metal. Export duty on tin realized only $6,153,360, as compared with $12,203,531 in 1920. The total revenue from mining amounted to $6,688,105.

The necessity for dealing with the accumulated tailings has been forced upon the Government owing to the silting of the rivers and consequent risk of floods. Orders have been issued for the stoppage of sluicing operations where tailings cannot be controlled. This may entail the closing of a considerable number of small mines.

The methods of mining in the Federated Malay States may be compared by showing the number of labourers employed in each class of mining. The total number of labourers employed at the end of the year was 86,338. This does not include the holders of "dulang" (pan) passes who numbered 13,418, mostly women. The labourers were distributed as follows :—

Open-cut and Surface . .	40,699
Underground	10,058
Hydraulic and Lampan .	29,973
Bucket Dredging . . .	5,608

Of the total labour force 80,110 were Chinese, 3,525 Indians, 2,307 Malays, 327 Europeans, and 70 others.

Thirty bucket dredges were in operation, and twenty-two more were proposed or under construction.

It is interesting to note the increase in the proportion of output from European-managed mines in late years as compared with the output from Chinese mines, as indicated by the figures in the accompanying table.

	European.	*Chinese.*
	%	%
1913 . . .	26	74
1919 . . .	32	68
1920 . . .	36	64
1921 . . .	39·2	60·8

Improved methods of mining will without doubt result in the saving of a considerable quantity of tin. Gravel pumps and bucket dredges are very popular, and mining by the old-fashioned methods is practically

dead, except in the case of lampanning, which is being discouraged.

The proportion of the total output of tin won from lode mining was 5·6%, as compared with 9·6% in 1920. Bucket dredges accounted for 13·5%.

The amount of gold disposed of was 14,674 ounces. One mine, the Raub Mine, in the State of Pahang, produced 14,430 oz.

The Malayan Collieries produced 299,351 tons of coal, an increase of 51,434 tons. The total amount produced from this company's mines since mining operations commenced is 1,175,950 tons. The railways consumed 144,934 tons and the mines 92,728 tons. The labour force was 2,700 men and power 1,891 h.p. Considerable advance has been made with the hydraulic stowage scheme, and the practice of replacing the coal extracted by sand hydraulically stowed is well established. Open-cut working has played an important part in the year's operations.

The total amount of tungsten ores exported was only 55 tons, as compared with 233·6 tons in 1920. This does not include the ores imported for treatment and re-exported.

The china-clay works at Gopeng, in the State of Perak, were brought to the producing stage and a good market has been found in India. The works produce fire-bricks of good quality, and will shortly be in a position to put on the market pottery of all kinds.

CAMBORNE

August 5.

Unemployment.—There is a slight improvement in the china-clay trade around the St. Austell district, but mining in the Redruth and Camborne areas is still in the unabsorbent stage. There is a scheme afoot for settling about 100 of these men in West Australia, and though admirable in a measure, it cannot be overlooked that these 100 men are required to be the best of their kind, strong, sturdy miners. Emigration is a means of relieving the situation, but at the expense of a future source of rates and the creation of labour difficulties when the mines reopen in earnest.

East Pool.—The sinking of the new shaft, which is now down 570 ft. from surface, had a slight setback during the month owing to a fissure being encountered in the shaft, letting out water at the rate of 1,800 gallons per hour. The experts of the François cementation process were requisitioned, and preparations were at once commenced to seal off the water. The sealing was accomplished about four days after the process was applied, and the miners are now continuing their sinking dry-shod. This is the first time cementation has been applied in Cornwall, and it is gratifying to be able to record such a successful achievement. Its possibilities for the future cannot be over-estimated. A sample of the cemented fissure shows a hard, compact mass of fluor-spar, quartz, chalcopyrite, felspar, and country rock all cemented together, and presenting the appearance of a brecciated lode. This homogeneity was brought about under an applied pressure of 1,700 lb. per square inch. The chimney stack is completed and the main headgear is in position on the ground ready for hoisting into place.

Levant.—The Treasury has approved the recommendation of the advisory committee under the Trades Facilities Act for a guarantee up to £10,000 for this deserving mine, but in order to have the advantage of this it is necessary for the directors to make certain arrangements which are now in hand. Meanwhile the advisory committee has asked them not to await completion of formalities, but to continue with the work for which the guarantee is to be granted. This work constitutes the reorganizing of the dressing and other plant, etc. One unit of the mill is already in operation on ore brought up from above the 170 fathom level. The ore-bins and rock-breaker are nearing completion, and the near future looks to seeing this interesting submarine mine in full swing again. About 120 men are at present employed.

South Crofty.—With a view to an early resumption of mining operations the erection of the 90 in. Cornish pump is proceeding apace. The main bob or beam is in position in its bearings, and the three Lancashire boilers that will supply steam to this engine are in their setting, which is approaching completion.

Tresavean.—This privately owned mine situated at Lanner, near Redruth, has been kept dry throughout the period of depression by its electric pumps, current being supplied by the Cornwall Power Co. from their works at Hayle. A better price for tin, or an equivalent in other directions, in common with other mines, will re-awaken activities. Tresavean has been an abundant copper producer in the past, and like most other copper mines in Cornwall this metal

has given place to tin in depth after passing a zone of indifferent ground.

St. Austell District.—The Kingsdown mine at Hewas Water continues its development underground. The 20,000 tons of developed ore, as well as the 3,000 tons at surface, call for the completion of the dressing-plant which is to be vigorously prosecuted. From April 24 to July 2, 737 ft. was developed on lodes of an average width of 3 ft., giving 36 lb. of black tin per ton by vanning assay. A few days ago a lode was intersected having a width of 10 ft. and carrying good values. The development costs range around 20s. per foot driven, and the handling costs inclusive of pumping and all charges from the ends to dump are 2s. 6d. per ton. It is to be hoped that these interesting figures will be accompanied by equally good milling results. More hands are being engaged and every effort is being made to reach the revenue stage.

The South Terras uranium-radium mine is now in fork, and ore is being raised to supply the needs of the mill and extraction plant for the ensuing twelve months; 200 tons of ore has been raised and is ready for chemical treatment; the radium content is estimated at 2,500 milligrammes. It will be remembered that owing to the wet situation mining operations are only carried on during the six months constituting the dry season. The new extraction plant has been in operation for the last three weeks, and the results therefrom fully come up to expectations. It is interesting to note that it is the first plant of its kind to be erected and operated in Cornwall for the extraction of radium salts; others may follow. Vigorous prospecting is being undertaken in the Grampound district for radio-active minerals and rare earths, and though St. Just and St. Ives have figured in this commodity at times the Grampound district has been by far the largest producer.

Prospecting for tin is being carried on in various parts of the county, but more especially in the St. Austell district. It offers an interesting field and several promising pitches have been overlooked in the predominant exploitation of china-clay. The late Mr. J. H. Collins said of one old copper mine in this district that probably no old copper mine in the country better deserved to be sunk in search of tin ore. The black tin in this district is usually of very high quality and metal content, especially in the clay areas.

PERSONAL

Frank H. Ahier has been appointed mine manager for the Shropshire Mines, Ltd., Minsterley.

W. L. Baillieu is here from Australia.

W. Barnes, of Ruston & Hornsby, Ltd., is visiting Australia and New Zealand.

F. O'D. Bourke is home from Nigeria.

Walter E. Gaby has concluded his geological examination of the Teziutlan copper-zinc property of the Mexican Corporation, and has returned to Sale Lake City.

W. H. Goodchild is back from Burma.

J. D. Hoffmann has returned from the Far East.

Edward Hooper has been elected chairman and managing director of the Namaqua Copper Company.

J. W. Kirkland has been elected president of the South African Institution of Engineers.

Newton B. Knox has gone to Czecho-Slovakia to examine a gold property.

Gulielmo Marconi has been awarded the John Fritz Medal.

E. P. Mathewson has returned to the United States.

R. M. Murray has been appointed acting general manager for the Mount Lyell Mining and Railway Co., Ltd.

W. T. Opie has left for Indo-China.

F. G. Rappoport has left for Peru.

Albert Victor Reis has received the degree of B.Sc. of Edinburgh University in the department of mining and metallurgy. This is the first award of the degree in this particular branch. Mr. Reis was the author of the paper on the mining of Spanish pyritic ore-bodies read before the Institution of Mining and Metallurgy last December.

Alexander Richardson has resigned as Principal of the Camborne School of Mines.

J. E. Snelus is home from Nigeria.

C. A. Süssmilch, a leading authority on the geology of New South Wales, has been elected president of the Royal Society of New South Wales.

G. A. Watermeyer has been elected president of the Chemical, Metallurgical, and Mining Society of South Africa.

A. Weinberg has left on his return to the Klondyke.

J. Jervis Garrard, consulting engineer to the Premier Hydraulic Tin Mines of Nigeria, Ltd., died on July 18.

Askin M. Nicholas died recently at Melbourne in his 62nd year. He was one of the pioneers of filter-pressing as applied in metallurgy.

H. A. Rogers died on June 20 at Johannesburg. He was born in the Cape Province, and was an early pioneer at Kimberley and on the Rand. He was on the board of many Barnato companies and of the Crown Mines and Ferreira Deep.

Lionel G. Robinson died on July 27, after a long and painful illness, at the age of 56. He was one of the best known members of the Stock Exchange associated with mining ventures, his firm, Lionel Robinson, Clark & Co., being concerned with many Broken Hill, Westralian, Victorian, and Queensland mining companies. He began life as a financial journalist in Melbourne, and when still a young man came over to this country to interest English capital in Australian ventures. He was also known in the world of sport, and was a good patron of cricket.

TRADE PARAGRAPHS

EDGAR ALLEN & Co., LTD., of the Imperial Steel Works, Sheffield, have issued a pamphlet relating to their "Imperial" Manganese Steel. This has a large application in the manufacture of crushing machinery, in conveying plant, and in the construction of parts of dredges, so the pamphlet will appeal to mining engineers.

THE CONSOLIDATED PNEUMATIC TOOL Co., LTD., of 170, Piccadilly, London, W. 1, and Fraserburgh, Scotland, send us their Pneumatic Tool Catalogue No. 42. The catalogue is devoted largely to Little Giant Hammers Drills for many classes of work, including rock-drilling. It also contains information relating to air-compressors, air-hose and its couplings and fittings, oil-engines, vacuum pumps, paint-spraying apparatus, etc.

THE GENERAL ELECTRIC Co., LTD., of Magnet House, Kingsway, London, W.C. 2, have forwarded us a copy of Section L (3) of their complete catalogue, dealing with Colliery Signalling Apparatus, Miners' Hand Lamps, etc. This list gives full particulars of the company's systems for haulage road signalling and signalling between onsetter and pit-bank, and the apparatus for use in connexion therewith. A useful series of flame-proof mining bells, for use below ground, and of iron-clad bells for use at the surface, tappers, keys, and pushes, and also batteries are listed, in addition to the "Kingsway II" Miners' Electric Safety Hand Lamp.

THE MERRILL COMPANY, of San Francisco, send us a circular letter dealing with the metallurgical plant for the New State Areas gold mine in the Far East Rand. In this plant many departures have been made from the long standardized African practice, and the use of the company's Merco Precipitation Processes will play a not unimportant part in the successful working of the mill. Most of the equipment to be used has been tried and proved in America, and several steps of the process have been in use in Africa for a number of years; nevertheless, it has required more than the usual degree of courage to embody all of them in this big unit and the results will be followed with a great deal of interest. The changes in crushing are radical, involving elimination of the traditional stamps, substituting therefor the horizontal Simons disc-crushers, and unusually large tube-mills (6 ft. 6 in. by 20 ft.). This increase in the size of the tube-mills has been made practicable by enlarging the openings in the discharge grids of the tubes; with a heavy original feed a considerable tonnage of unground, partially rounded pebbles, approximating 30 to 40 tons per tube per day are discharged from the mill. These pebbles are separated from the pulp by a trommel of ½ in. aperture, and the oversize, after passing through a set of "cracking" rolls, is returned to the mill. This procedure has materially improved the tube-mill crushing efficiency and the elimination of the stamps and amalgamating plates is expected to effect a big saving in capital cost. Dorr classifiers will take the place of return cones heretofore universally used for classification. It should be remembered that in Africa no steel or iron balls are used for grinding, large quantities of mine rock of from 4 to 7 in. ring being fed to the tubes instead. The large rectangular concrete tanks of Chuquicamata and Ajo are to be used as slime collectors and pulp storages, and are expected to show economy in first cost, space, and maintenance. Butters slime filters will be used and the solution refiltered through sand clarifiers. The adoption of the Merrill and Crowe Precipitation Processes follows the notable results obtained at the nearby Brakpan and Modder B plants. The Merrill Process of zinc-dust precipitation was installed at both of these mines in 1911, and while good results were obtained the precipitation of the very weak slime solutions used on the Rand always required careful watching and the addition of a little free cyanide to obtain good barrens. When the Crowe Process was introduced on the Rand in 1921, Brakpan and Modder B were among the first plants to install, and the results obtained must be considered close to finality in precipitation practice. No difficulty is experienced in obtaining perfect precipitation, that is, "trace" barrens of under one cent, irrespective of cyanide, alkali, or metal content of the solution, and with a zinc consumption of from 0·04 to 0·06 lb., per ton of solution. Neither plant precipitates more than 1½ tons of solution per ton of ore milled, so that the zinc consumption per ton milled probably averages from 0·05 to 0·07 lb., which is undoubtedly a really good result.

METAL MARKETS

COPPER.—The tendency on the London standard copper market during July was firm, and a small advance was recorded in values. The month opened fairly firm, the weakness which had been evident in June being dissipated by some American support, and the good tone was maintained to the end. For the first fortnight or so, sentiment in London was considerably assisted by the good reports emanating from America, but later on the protracted industrial troubles on the other side of the Atlantic had a somewhat unnerving effect on American consumers, with the result that the price of electrolytic in New York weakened slightly. This, however, was not appreciably reflected in London, thanks to an improving tendency in the British copper-consuming industries which gave market opinion here an optimistic tinge. Business with the Continent was greatly hindered by the oscillations of the exchanges, and, indeed, there is little prospect of anything approaching stable conditions until the Powers make a serious attempt to solve the huge post-war problems that are so adversely influencing the flow of world-trade. Meanwhile, various Continental countries are contemplating large-scale electrification schemes, so that eventually a good demand should be seen from Europe as soon as financial conditions permit. The position in America has not recently undergone much alteration, producing interests being still more or less in control of the market. A rather unwelcome development is the statement that various big American producers will not in future publish statistics of their monthly output. India showed a little consuming interest during the month.

Average price of cash standard copper: July, 1922, £63 3s. 7d.; June, 1922, £62 0s. 11d.; July, 1921, £71 4s. 4d.; June, 1921, £71 18s. 2d.

TIN.—The tone of the standard tin market at the commencement of July was steady, but later on considerable professional support made its appearance, under the influence of which values rose appreciably. The interests responsible for the advance were a group which are usually well-informed as regards the situation, and it was believed that their operations were based on the anticipation that the July statistics would reveal

London Daily Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long Ton

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
July 11	62 18 9 to 63 0 0	63 7 6 to 63 8 9	70 5 0 to 71 15 0	71 15 0	66 0 0 to 68 0 0
12	63 3 9 to 63 5 0	63 11 3 to 63 12 6	70 5 0 to 71 15 0	71 15 0	— —
13	63 5 0 to 63 6 3	63 13 9 to 63 15 0	70 5 0 to 71 15 0	71 15 0	— —
14	63 0 0 to 63 2 6	63 8 9 to 63 10 0	70 5 0 to 71 15 0	71 15 0	66 0 0 to 68 0 0
17	63 1 3 to 63 2 6	63 8 9 to 63 10 0	70 10 0 to 72 0 0	72 0 0	— —
18	63 2 6 to 63 5 0	63 8 9 to 63 11 3	70 10 0 to 72 0 0	72 0 0	66 0 0 to 68 0 0
19	63 0 0 to 63 2 6	63 7 6 to 63 8 9	70 10 0 to 72 0 0	72 0 0	— —
20	63 2 6 to 63 5 0	63 7 6 to 63 10 0	70 10 0 to 72 0 0	72 0 6	— —
21	63 5 0 to 63 7 6	63 12 6 to 63 15 0	70 10 0 to 72 0 0	72 0 0	66 0 0 to 68 0 0
24	63 10 0 to 63 12 6	63 15 0 to 63 17 6	70 10 0 to 71 10 0	71 10 0	— —
25	63 7 6 to 63 10 0	63 12 6 to 63 15 0	70 10 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
26	63 7 6 to 63 10 0	63 12 6 to 63 15 0	70 10 0 to 71 10 0	71 10 0	— —
27	63 12 6 to 63 15 0	63 17 6 to 64 0 0	70 10 0 to 71 10 0	71 10 0	— —
28	63 17 6 to 64 0 0	64 2 6 to 64 5 0	70 10 0 to 71 10 0	71 10 0	56 0 0 to 68 0 0
31	64 5 0 to 64 7 6	64 7 6 to 64 10 0	71 0 0 to 72 0 0	72 0 0	— —
Aug. 1	64 12 6 to 64 15 0	64 15 0 to 64 17 6	71 0 0 to 72 0 0	72 0 0	67 0 0 to 69 0 0
2	65 7 6 to 65 10 0	65 7 6 to 65 10 0	71 0 0 to 72 0 0	72 0 0	— —
3	65 7 6 to 65 10 0	65 7 6 to 65 10 0	71 0 0 to 72 0 0	72 0 0	— —
4	65 2 6 to 65 5 0	65 2 6 to 65 5 0	71 0 0 to 72 0 0	72 0 0	67 0 0 to 69 0 0
8	65 2 6 to 65 5 0	65 2 6 to 65 5 0	71 0 0 to 72 0 0	72 0 0	67 0 0 to 69 0 0
9	64 12 6 to 64 15 0	64 15 0 to 64 17 6	71 0 0 to 72 0 0	72 0 0	— —

a considerable diminution in visible supplies. General market opinion also inclined to this view, it being believed that the shipments from the Straits would be shown to have been on a rather small scale. Consuming interest in the market, on the other hand, continued rather quiet. The South Welsh tinplate maker's are still encountering rather poor business, and consequently their takings of tin are not voluminous. Continental business remained poor during the month; and American buying was spasmodic, as usual, consumers over there being somewhat apprehensive of the effects of the present strikes. Consumption in America, however, is undoubtedly excellent at the moment, and as soon as stocks have been absorbed fresh buying is likely to materialize from that quarter. As regards quotations on the London market, it remains to be seen whether prices can be indefinitely maintained by the professional operators, since, although market sentiment on the whole is far from pessimistic, more trust would be felt in the position if the advance had been under the pressure of broadened consumptive demand, instead of under the stress of manipulative tactics. The extent to which the position is under control can be gauged from the fact that the contango disappeared altogether during the month, a clear indication of the tightness with which spot metal is held.

Average price of cash standard tin: July, 1922, £156 4s. 4d.; June, 1922, £152 12s. 3d.; July, 1921, £164 13s. 1d.; June, 1921, £167 12s. 10d.

Lead.—An easier tendency which manifested itself in the London lead market at one time aroused hopes among consumers generally that the position was at last moving in their favour, and it was expected in some quarters that quotations were about to recede steadily towards less inflated levels. The weakness, however, was only temporary, and with fresh arrivals of metal comparatively restricted, with holders adhering to their firm attitude, and with a burst of buying by the big cable industries, prices again advanced, and the premium on prompt metal, which at one time showed signs of disappearing, broadened again to a considerable figure. Values on balance showed an advance during the month. At the moment there seems little prospect of much immediate change in the situation, since, although shipments are tending to expand slightly, the increased interest on the part of a section of the consuming trades more than counterbalances this factor; with the result that economic prices are still denied to the bulk of the lead-using industries.

Average price of soft foreign lead: July, 1922, £24 6s. 11d.; June, 1922, £24 3s. 2d.; July, 1921, £23 5s. 10d.; June, 1921, £22 9s. 1d.

Spelter.—A steady rise was witnessed in spelter values during July. With a fair inquiry emanating from galvanizers, and with available supplies restricted, it was inevitable that quotations should harden. Very little metal was offered from Belgium, Germany, Poland, and Scandinavia, while, although some sales were made by America, these were insufficient to turn the balance of the market. It may be, however, that better supplies will come on to the London market in the near future, since the present level of quotations must be remunerative to practically all producers, especially Continental makers, who benefit from the weakness in their exchange when selling here. Meanwhile, English producers have become rather more reserved than they were, and they are apparently not finding much difficulty in disposing of their monthly output of 2,000 tons or so. In America the position of the metal is sound, with stocks continuing to decrease. In the United Kingdom stocks are also gradually diminishing, and it seems as if spot supplies will become still tighter unless increased offers are made by producers. It is significant that the backwardation widened from 2s. 6d. to 10s. during the month.

Average price of spelter: July, 1922, £28 18s. 5d.; June, 1922, £27 16s. 1d.; July, 1921, £26 12s.; June, 1921, £27 2s. 2d.

Zinc Dust.—Prices are nominal as follow: Australian high-grade, £50; American 92 to 94%, £47 10s.; and English 90 to 92%, £47 10s. Inferior grades are obtainable at somewhat cheaper figures.

Prices on the London Metal Exchange.
Silver per Standard Ounce ; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	d.	d.	s. d.	July
24 2 6 to 23 5 0	25 15 0	28 6 3 to 28 3 9	153 10 0 to 153 12 6	154 5 0 to 154 7 6	35⅞	35⅞	92 10	11
24 5 0 to 23 7 6	25 15 0	28 5 0 to 28 2 6	153 7 6 to 153 10 0	154 3 9 to 154 6 3	35⅝	35½	93 0	12
24 5 0 to 23 7 6	26 0 0	28 10 0 to 28 7 6	153 2 6 to 153 5 0	153 15 0 to 154 0 0	35⅝	35½	92 9	13
24 12 6 to 23 12 6	26 0 0	28 15 0 to 28 12 6	153 5 0 to 153 7 6	153 17 6 to 154 0 0	35¾	35⅝	92 9	14
24 16 3 to 23 13 9	26 5 0	29 0 0 to 29 0 0	153 12 6 to 153 15 0	154 7 6 to 154 10 0	35½	35⅜	92 8	17
24 17 6 to 23 15 0	26 5 0	29 5 0 to 29 3 9	155 2 6 to 155 5 0	155 12 6 to 155 15 0	35½	35⅜	92 9	18
25 2 6 to 23 17 6	26 10 0	29 6 3 to 29 3 9	156 0 0 to 156 2 6	156 10 0 to 156 12 6	35¼	35⅛	92 5	19
25 10 0 to 24 2 6	26 15 0	29 12 6 to 29 10 0	156 10 0 to 156 12 6	156 17 6 to 157 0 0	35⅛	35⅜	92 7	20
25 12 6 to 24 2 6	26 15 0	29 12 6 to 29 5 0	157 5 0 to 157 7 6	157 10 0 to 157 12 6	25¼	35¼	92 6	21
25 12 6 to 24 2 6	26 15 0	29 12 6 to 29 7 6	158 0 0 to 158 2 6	158 2 6 to 158 5 0	35¼	35	92 5	24
25 12 6 to 24 2 6	26 15 0	29 12 6 to 29 7 6	158 5 0 to 158 7 6	158 7 6 to 158 10 0	35	35	92 5	25
25 15 0 to 24 10 0	27 0 0	29 17 6 to 29 10 0	160 5 0 to 160 7 6	160 5 0 to 160 7 6	35¼	35⅛	92 7	26
25 15 0 to 24 12 6	27 0 0	30 5 0 to 29 12 6	162 15 0 to 163 0 0	162 15 0 to 163 0 0	35⅜	35⅜	92 8	27
25 15 0 to 24 12 6	27 0 0	30 7 6 to 29 17 6	161 10 0 to 161 15 0	161 10 0 to 161 15 0	35¼	35¼	92 8	28
25 12 6 to 24 12 6	27 0 0	31 5 0 to 30 15 0	162 10 0 to 162 12 6	162 10 0 to 162 12 6	35¼	35¼	92 8	31
								Aug.
25 5 0 to 24 10 0	26 15 0	31 5 0 to 30 17 6	162 15 0 to 162 17 6	162 15 0 to 162 17 6	35⅛	35⅛	92 8	1
25 7 6 to 24 10 0	26 15 0	31 15 0 to 31 5 0	159 15 0 to 159 17 6	159 15 0 to 159 17 6	35¼	35⅛	92 9	2
25 7 6 to 24 10 0	26 15 0	31 10 0 to 31 2 6	159 2 6 to 159 5 0	159 2 6 to 159 5 0	35⅛	35⅛	92 9	3
25 7 6 to 24 10 0	27 0 0	31 12 6 to 31 0 0	160 17 6 to 161 0 0	160 17 6 to 161 0 0	35⅛	35⅛	92 8	4
25 2 6 to 24 2 6	26 10 0	31 12 6 to 30 15 0	161 12 6 to 161 15 0	161 12 6 to 161 15 0	34⅞	34⅞	92 5	8
25 2 6 to 24 2 6	26 10 0	31 5 0 to 30 7 6	160 2 6 to 160 5 0	160 5 0 to 160 7 6	34¾	34¾	92 6	9

Antimony.—The market is steady, English regulus, ordinary brands, being still quoted at £27 to £29 10s. per ton, rather nominal, while special brands are priced at £32 10s. to £35. Foreign regulus is procurable at £24 15s. ex warehouse, and forward delivery is offered at down to £23 10s. c.i.f.

Arsenic.—Not much business is passing, but the quotation for Cornish white 99% is firm at £44 per ton, delivered London.

Bismuth.—A fair business appears to be taking place, and the quotation is maintained at 9s. per lb.

Cadmium.—The price is slightly easier on the month at 5s. 6d. to 5s. 9d. per lb. There is a moderate demand manifest.

Aluminium.—Domestic producers quote £100 per ton for home and £105 for export. Foreign material is offering at about £85 f.o.b. Continental ports, but no very substantial buying is in evidence.

Nickel.—The leading makers have reduced their quotation by £10 per ton, £150 per ton being now asked for both home and export business.

Cobalt Metal.—Offering at 10s. to 10s. 6d. per lb.

Cobalt Oxides.—Unchanged at 10s. per lb. for grey and 9s. for black, with some business passing at less.

Platinum.—Demand is steady and prices remain unaltered. Manufactured metal is priced at £19 and raw at £17 per oz.

Palladium.—Manufactured (sheets and wire) £16 per oz. ; raw £12 10s.

Quicksilver.—The market is quiet and steady at about £11 2s. 6d. to £11 5s. per bottle, on spot.

Selenium.—Powder is still priced at 7s. 9d. per lb.

Tellurium.—Sellers ask 40s. per lb.

Manganese Ore.—Prompt supplies are short, Indian grades being especially difficult to procure. The price of Indian is nominal at 1s. 2d. per unit, c.i.f., and ordinary Caucasian is about 1s. 2¼d.

Chrome Ore.—The price is unchanged since our last report, 48 to 50% being quoted at £4 5s. c.i.f.

Sulphate of Copper.—The value has eased slightly, £26 to £27 being quoted for both home and export.

Tungsten Ore.—Spot material commands about 14s. and Chinese prompt shipment has recently been done at 12s. 11d. c.i.f., and the market shows signs of firming-up.

Molybdenite.—The quotation for 85% MoS_2 is steady at 32s. 6d. per unit, c.i.f.

Silver.—The quotation weakened somewhat during the month, but the market was not characterized by any particularly salient feature. Spot bars were quoted at 36⅜d. on July 1, advanced to 36⅝d. on the 4th, reacted to 35⅞d. on the 6th, and rose again to 36¼d. on the 8th. On the 12th the price was down again to 35⅝d., and although on the 14th this figure was exceeded by ⅛d., the quotation receded to 35⅛d. on the 19th. Subsequent fluctuations were unimportant, and the price closed at 35¼d. on July 31.

Graphite.—Values are easy, Madagascar, 80 to 90%, being priced at about £13.

Iron and Steel.—After a period of six years' duration, Cleveland ironmasters have decided to abolish the fixing of prices for pig iron, and while business in this market has not revived to the extent which was hoped would occur, prices have continued the downward trend, and at the end of the month No. 3 Cleveland G.M.B. was selling at 87s. 6d. a ton. This is a big drop from the highest price reached, 225s. American demand has revived a little, and some business has been put through, but generally speaking export and home buying continues on a very limited scale. Hematite is weak with export sales moving at around 88s. Stocks are accumulating, and there is talk of reducing output. Though no alteration has been made in values for manufactured iron and steel, the tendency is, without doubt, towards lower levels, and while such is the case consumers naturally are only purchasing from hand to mouth. Continental competition is again being felt in several branches, and therefore there is again competition among our own makers to secure any orders about.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of Gold per oz.
	Oz.	Oz.	Oz.	s. d.
July, 1921	673,475	16,080	689,555	112 6
August	695,230	16,296	711,526	111 6
September	674,157	16,939	691,096	110 0
October	690,348	17,477	707,825	103 0
November	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921	7,924,534	190,052	8,114,586	—
January, 1922 / February / March	594,788	44,940	639,728	95 6 / 92 6 / 94 0
April	493,402	17,936	511,338	92 0
May	612,702	17,083	629,786	92 0
June	658,032	17,665	675,697	92 6

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
April 30, 1921	172,826	14,908	1,316	189,050
May 31	170,595	14,510	1,302	186,407
June 30	168,152	14,704	1,317	184,173
July 31	166,999	14,688	1,246	182,933
August 31	169,008	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,410	13,465	1,217	191,092
December 31	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169
June 30	170,464	12,117	1,211	183,792

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1921	1,966,349	35 10	25 10	10 0	979,769
July	2,010,236	37 2	25 7	11 7	1,163,565
August	2,050,722	37 3	25 4	11 11	1,226,282
September	1,997,086	36 8	25 2	11 6	1,151,127
October	2,041,581	34 4	24 9	9 7	981,597
November	2,007.617	34 6	24 9	9 9	978,931
December	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922 / February / March	1,624,333	33 10	49 0	15 2*	1,233,033*
April	1,414,843	31 7	24 3	7 4	519,365
May	1,772,793	31 4	22 8	8 8	767,533

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May	46,266	48,744	53,920
June	45,054	49,466	55,614
July	46,208	51,564	—
August	48,740	53,200	—
September	45,471	52,436	—
October	47,[illegible]	53,424	—
November	46,782	53,098	—
December	46,190	55,968	—
Total	552,498	591,525	323,458

Transvaal Gold Outputs.

	May		June	
	Treated Tons	Yield Oz.	Treated Tons	Yield Oz.
Aurora West	9,400	£12,197*	8,740	£12,438†
Brakpan	52,500	25,525	58,000	25,816
City Deep	84,000	34,979	86,000	36,513
Cons. Langlaagte	33,600	£44,550*	35,900	£48,188†
Cons. Main Reef	45,600	15,855	44,600	15,871
Crown Mines	161,000	49,478	172,000	53,049
D'rb'nRoodepoortDeep	26,500	8,675	27,500	9,321
East Rand P.M.	102,000	26,012	106,500	26,648
Ferreira Deep	20,200	5,278	26,200	7,004
Geduld	45,800	16,333	44,600	16,257
Geldenhuis Deep	48,178	12,259	52,787	12,714
Glynn's Lydenburg	4,036	£6,578§	4,244	£6,488‡
Goch	16,550	£16,969*	15,800	£16,958†
Government G.M. Areas	139,000	£280,323*	141,000	£285,522†
Kleinfontein	42,100	10,313	42,000	11,547
Knight Central	24,000	5,286	28,500	5,833
Langlaagte Estate	40,700	£59,833*	42,200	£63,908†
Luipaard's Vlei	13,915	£11,539*	17,910	£19,249†
Meyer & Charlton	12,000	£31,347*	13,800	£36,468†
Modderfontein, New	98,000	43,677	106,000	48,183
Modderfontein B	55,000	27,549	60,000	32,665
Modderfontein Deep	44,400	23,592	43,300	23,180
Modderfontein East	25,900	8,823	25,500	10,283
New Unified	10,600	£10,206*	10,600	£11,600†
Nourse	42,500	13,489	43,800	13,932
Primrose	16,500	£17,763*	17,800	£19,450†
Randfontein Central	103,500	£143,263*	119,509	£163,196†
Robinson	13,500	4,593	14,590	4,904
Robinson Deep	51,509	16,154	60,700	17,430
Roodepoort United	9,450	£9,010*	9,409	£8,299†
Rose Deep	43,400	10,744	47,200	12,360
Simmer & Jack	37,600	9,523	40,100	10,481
Springs	43,500	18,191	43,000	18,606
Sub-Nigel	8,800	5,714	10,000	6,050
Transvaal G.M. Estates.	15,790	£24,326§	15,490	£24,089‡
Van Ryn	26,900	£34,991*	32,200	£41,386†
Van Ryn Deep	54,000	£117,418*	55,100	£122,301†
Village Deep	52,000	16,548	54,100	16,632
West Rand Consolidated	32,500	£41,157*	31,000	£41,538†
Witw'tersr'nd (Knights)	33,000	£45,310*	39,600	£50,764†
Witwatersrand Deep	30,000	9,798	32,800	10,663
Wolhuter	32,000	6,991	32,500	7,889

* £4 12s. per oz. ‡ £4 10s. per oz. † £4 12s. 6*d*. per oz. § £4 10s. per oz.

Rhodesian Gold Outputs.

	May		June	
	Tons	Oz.	Tons	Oz.
Cam & Motor	14,800	5,409	14,800	5,472
Falcon	16,200	3,100*	16,266	3,120‖
Gaika	4,260	1,936	—	—
Globe & Phœnix	6,404	6,244	6,318	6,481
Jumbo	1,600	468	1,450	522
London & Rhodesian	4,018	£5,072	—	—
Lonely Reef	5,500	4,130	5,440	4,039
Planet-Arcturus	5,900	2,049	5,580	1,988
Rezende	6,000	2,821	5,900	2,895
Rhodesia G.M. & I.	307	209	233	176
Shamva	61,050	£38,384‡	56,700	£36,783§
Transvaal & Rhodesian	1,700	£5,088†	1,655	£4,733†

* Also 293 tons copper. † At par. ‖ Also 296 tons copper. § Gold at £4 10s. per oz. ‡ Gold at £4 11s. per oz.

West African Gold Outputs.

	May		June	
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,530	£11,873*	6,920	£11,939*
Abosso	7,450	3,004	7,400	2,965
Ashanti Goldfields	6,101	5,095	6,083	5,277
Obbuassi	517	401	540	£2,100†
Prestea Block A	8,205	£14,784†	8,379	£15,760*
Taquah	2,508	1,414	2,024	1,155

* At par. † Including premium.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
October, 1921	1,910	51,286	53,196	225,959
November	156	46,429	46,585	197,879
December	451	53,348	53,799	228,522
January, 1922.....	329	37,851	38,180	162,177
February	926	41,194	42,120	178,913
March............	180	42,842	43,022	182,745
April............	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June	136	49,158	49,294	209,386
July	366	42,774	43,140	183,247

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	oz.	oz.	oz.	£
January .	38,181	4,411	448	11,855
February.	42,121	8,063	1,200	12,325
March ...	43,022	11,717	1,069	12,960
April	46,394	4,186	6,219	6,589
May	39,725	10,049	—	13,100
June.....	49,294	—	—	6,784
July	43,140	—	—	—
August...	—	—	—	—
September	—	—	—	—
October .	—	—	—	—
November	—	—	—	—
December	—	—	—	—
Total ..	301,877	38,428	8,936	63,613

Australasian Gold Outputs.

	May		June	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	5,977	6,619‖	6,135	7,444‖
Blackwater (N.Z.)	3,770	7,560*	3,620	6,689*
Gold'n Horseshoe (W.A)	10,212	5,454‡	10,320	5,530‡
Grt Boulder Pro. (W.A.)	10,061	28,170‖	9,540	26,712‖
Hampton Celebr. (W.A.)	960	2,025	870	1,859‖
Ivanhoe (W.A.)	15,116	6,463‡	15,893	6,498‡
Lake View & Star (W.A.)	6,457	10,734‖	6,862	11,792‖
Menzies Con. (W.A.) ..	2,000	3,892	2,000	3,804
North Kalgurli (W.A.).	177	179‡	—	—
Oroya Links (W.A.) ...	1,720	9,579‖†	—	—
South Kalgurli (W.A.) .	7,353	12,334‖	7,544	12,743‖
Waihi (N.Z.)..........	14,485	3,945‡ 36,585§	15,156	4,328‡ 30,247§
„ Grand Junc'n (N.Z.)	—	—	—	—

* Including premium ; † Including royalties ; ‡ Oz. gold ; § Oz. silver ; ‖ At par.

Miscellaneous Gold and Silver Outputs.

	May		June	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	151*p*	—	206*p*
Colombian Mining (C'lbia)	—	—	2,100	5,045
El Oro (Mexico)	35,380	177,683†	34,151	175,757†
Esperanza (Mexico)	—	4,247*e*	—	1,979*e*
Frontino & Bolivia (C'lbia)	2,040	7,868	2,090	7,338
Keeley Silver (Canada) ..	—	37,500*s*	—	37,500*s*
Mexico El Oro (Mexico)..	13,400	188,720†	13,315	247,660†
Mining Corp. of Canada .	8,189	118,853	—	—
Oriental Cons. (Korea) ...	—	89,000†	—	78,000†
Ouro Preto (Brazil)	7,800	2,783‖	6,800	2,830
Plym'th Cons. (Calif'rnia	8,300	9,532*	8,200	9,074*
St. John del Rey (Brazil).	—	45,500*	—	38,000*
Santa Gertrudis (Mexico)	35,274	28,559*e*	40,868	65,705*e*
Tomboy (Colorado)	19,000	73,000†	18,000	76,000†

* At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. *p* Oz. platinum and gold. *s* Oz. silver. *e* Profit in dollars.

Nechi (Colombia) : 22 days to July 1, $24,161 from 204,585 cu. yd. ; 18 days to July 19, $11,026 from 109,700 cu. yd.

Pato (Colombia) : 15 days to July 2, $47,764 from 90,762 cu. yd. ; 18 days to July 20, $16,948 from 79,945 cu. yd.

Gold Outputs, Kolar District, India.

During June, 1922.

	Tons Ore	Oz.	Tons Tailing	Oz.	Total Oz.
Balaghat	3,600	1,914	8,700	634	2,548
Champion Reef .	11,912	3,691	22,335	1,219	4,910
Mysore	18,285	6,129	47,762	4,373	10,502
North Anantapur.	500	639	700	83	722
Nundydroog	9,258	4,455	15,048	622	5,077
Ooregum	12,900	7,564	13,440	905	8,469

Total Gold Output for all India : February, 34,690 oz.; March, 35,607.

Base Metal Outputs.

		May	June
Broken Hill British....	Tons lead carb. ore.	410	420
	Tons lead conc.	2,641	2,464
	Tons zinc conc......	2,355	2,260
Broken Hill Prop......	Tons lead conc. ...	1,753	1,308
	Tons zinc conc.	6,027	6,391
Broken Hill South	Tons lead conc.	5,193	4,725
Burma Corporation....	Tons refined lead ..	3,140	3,281
	Oz. refined silver ..	296,392	379,683
Electrolytic Zinc	Tons zinc............	1,825	1,981
Fremantle Trading ...	Tons lead............	209	401
Mount Lyell	Tons copper	392	489
	Oz. silver	7,586	9,434
	Oz. gold	123	112
Mount Morgan	Tons copper	—	708*
	Oz. gold	—	6,950*
North Broken Hill.....	Tons lead conc......	2,070	2,075
	Tons zinc conc......	1,840	1,840
Poderosa..............	Tons copper ore	600	550
Rhodesia Broken Hill	Tons lead	1,904	1,822
San Francisco Mexico	Tons lead conc.	—	1,950
	Tons shipping ore ..	—	38
Sulphide Corporation ..	Tons lead conc. ...	2,343	3,378
	Tons zinc conc	4,011	5,983
Union Minière	Tons copper	3,798	—
Transvaal Silver	Tons silver-lead bullion	401	397
Zinc Corporation	Tons zinc conc......	9,345	9,035
	Tons lead conc. ...	1,380	950

* Six weeks to June 25.

Imports of Ores, Metals, etc., into United Kingdom.

		May	June
Iron Ore	Tons	410,821	270,924
Manganese Ore	Tons	31,518	18,798
Iron and Steel	Tons	60,939	52,797
Copper and Iron Pyrites	Tons	64,806	22,840
Copper Ore, Matte, and Prec.	Tons	456	2,402
Copper Metal	Tons	2,483	4,061
Tin Concentrate	Tons	2,820	4,202
Tin Metal......................	Tons	2,222	1,502
Lead, Pig and Sheet	Tons	15,860	10,437
Zinc (Spelter)	Tons	7,698	6,088
Zinc Sheets, etc................	Tons	777	822
Quicksilver	Lb.	—	63,428
Zinc Oxide.....................	Tons	358	340
White Lead	Cwt.	13,112	9,845
Red and Orange Lead	Cwt.	2,035	3,155
Barytes, ground	Cwt.	54,665	44,566
Asbestos	Tons	1,313	1,376
Boron Minerals	Tons	2,660	677
Borax	Cwt.	3,240	3,005
Basic Slag	Tons	3,203	7,580
Phosphate of Lime..............	Tons	45,473	40,517
Mica..........................	Tons	87	118
Sulphur	Tons	5,628	3,946
Nitrate of Soda.................	Cwt.	62,140	20,740
Potash Salts	Cwt.	277,620	170,784
Petroleum : Crude	Gallons	32,485,858	8,210,641
Lamp Oil	Gallons	17,736,493	7,256,603
Motor Spirit	Gallons	36,129,440	33,376,261
Lubricating Oil	Gallons	2,708,551	5,365,168
Gas Oil	Gallons	8,501,031	9,160,832
Fuel Oil	Gallons	32,411,674	29,589,999
Asphalt and Bitumen............	Tons	6,978	17,031
Paraffin Wax	Cwt.	79,041	79,839
Turpentine	Cwt.	24,638	45,220

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	April	May	June
	Tons	Tons	Tons
Nigeria :			
Bisichi	25	22½	32
Ex-Lands	35	30	—
Filani	2	2	1½
Gold Coast Consolidated	—	—	—
Gurum River	9	9	8
Jos	8	10¾	10½
Kaduna	15¾	3¾	3
Kaduna Prospectors	9¼	4¾	5
Keffi Consolidated	20	20	20
Lower Bisichi	3½	4	6½
Mongu	33½	30	25
Naraguta	40	37	50
Naraguta Extended	7	8	15
Nigerian Consolidated	8	7	8½
N.N. Bauchi	36½	45	56
Rayfield	40	40	50
Ropp	143	180	163
Rukuba	4	3	2
South Bukeru	20	20	12
Tin Fields	8	—	6
Yarde Kerri	9½	8	5
Federated Malay States :			
Chenderiang	—	—	74*
Gopeng	72	72	62½
Idris Hydraulic	19¼	18¼	19
Ipoh	19½	24½	18¾
Kamunting	—	—	86*
Kinta	40	37	34¼
Lahat	26¼	37¾	34¾
Malayan Tin	77½	77½	80¼
Pahang	234	219½	215
Rambutan	19½	20	19½
Sungei Besi	39	39	42
Tekka	42	36	31
Tekka-Taiping	30	23	15
Tronoh	74	89	74
Other Countries :			
Aramayo Mines (Bolivia)	259	249	219
Berenguela (Bolivia)	38	34	34
Briseis (Tasmania)	—	—	—
Deebook Ronpibon (Siam)	21½	21	21
Leeuwpoort (Transvaal)	—	—	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	85½	66	—
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	93¼	120	116¼
Tongkah Harbour (Siam)	88	98	115
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note.—These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	667	678	613	547	438	473
February	646	668	623	477	270	412
March	655	707	606	505	445	456
April	555	584	546	467	394	434
May	509	525	483	383	337	479
June	473	492	484	435	423	—
July	479	545	481	484	494	—
August	551	571	616	447	477	—
September	538	520	561	528	595	—
October	578	491	625	628	546	—
November	621	472	536	544	564	—
December	655	518	511	577	555	—
Total	6,927	6,771	6,685	6,022	5,618	2,251

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,030	3,765	4.265	3,298	3,143
February	3,197	2,734	3.014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	2,969
July	3,373	3,756	2,824	2,734	—
August	3,259	2,956	2,786	3,051	—
September	3,157	3,161	2,734	2,338	—
October	2,870	3,221	2,837	3,161	—
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	17,463

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	May 31	June 30	July 31
Straits and Australian Spot	999	1,151	2,361
Ditto, Landing and in Transit	560	670	475
Other Standard, Spot and Landing	5,804	4,690	4,254
Straits, Afloat	1,100	2,555	650
Australian, Afloat	60	45	75
Banca, in Holland	2,857	2,776	2,700
Ditto, Afloat	502	1,214	459
Billiton, Spot	72	60	27
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	630	572	610
Total Afloat for United States	7,730	6,452	5,137
Stock in America	1,921	2,371	2,616
Total	22,235	22,558	20,364

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	May	June	July
Shipments from :			
Straits to U.K.	1,050	2,595	720
Straits to America	4,860	3,465	2,890
Straits to Continent	510	445	425
Straits to other places	175	100	150
Australia to U.K.	—	—	50
U.K. to America	125	355	490
Imports of Bolivian Tin into Europe	1,233	2,462	202
Supply :			
Straits	6,420	6,505	4,035
Australian	—	—	50
Billiton	—	—	—
Banca	1,835	1,229	846
Standard	616	545	684
Total	8,871	8,279	5,615
Consumption :			
U.K. Deliveries	2,047	1,929	2,420
Dutch ,,	274	299	313
American ,,	4,740	5,130	4,590
Straits, Banca & Billiton, Continental Ports, etc.	819	598	486
Total	7,880	7,956	7,809

Imports and Exports of Gold and Silver

During June, 1922.

		Imports.	Exports.
Gold :	Unrefined Bullion.... £	736,121	—
	Refined Bars........ ,,	1,821,957	1,800,414
	Coin .... ,,	—	257,777
Silver :	Unrefined Bullion ... oz.	417,180	—
	Refined Bars........ ,,	2,149,432	6,200,067
	Coin .... £	162,267	113,755

Outputs Reported by Oil-producing Companies.

In Tons.

	Apr.	May	June.
Anglo-Egyptian	12,290	15,564	17,893
Anglo-Texas	1,892	1,922	1,994
Anglo-United	954	—	
Apex Trinidad	4,450	7,600	5,000
Astra Romana	32,698	35,400	32,800
British Burmah	10,285	10,633	10,084
Caltex	8,063	11,613	10,348
Dacia Romana	205	798	553
Indo-Burma	—	—	—
Kern River	16,712	15,814	12,339
Lobitos	8,691	8,903	8,697
Phœnix	2,289	3,216	6,289
Romana Americana	20,348	26,300	26,300
Roumanian Consolidated	2,120	2,307	1,814
Santa Maria	2,021	1,629	1,415
Steaua Romana	17,570	18,697	18,427
Trinidad Leaseholds	8,500	9,550	8,500
United of Trinidad	4,170	3,293	3,924

Quotations of Oil Companies' Shares.

Denomination of Shares £1 unless otherwise noted.

	July 5, 1922			Aug. 4, 1922		
	£	s.	d.	£	s.	d.
Anglo-American	4	11	3	4	5	0
Anglo-Egyptian B	1	15	0	1	6	0
Anglo-Persian 1st Pref.	1	5	6	1	5	6
Apex Trinidad	1	17	6	2	0	0
British Borneo (10s.)		12	6		10	6
British Burmah (8s.)		12	0		10	6
Burmah Oil	5	5	0	5	0	0
Caltex ($1)		2	0		1	9
Dacia Romano	1	0	0		17	6
Kern River, Cal. (10s.)	1	1	0	1	0	3
Lobitos, Peru	4	18	9	5	7	6
Mexican Eagle, Ord. ($5)	3	5	0	2	14	0
,, ,, Pref. ($5)	3	1	3	2	11	3
North Caucasian (10s.)		11	3		10	6
Phœnix, Roumania	1	8	0	1	6	6
Roumanian Consolidated		18	9		17	6
Royal Dutch (100 gulden)	39	5	0	36	0	0
Scottish American		2	3		2	0
Shell Transport, Ord.	4	13	9	4	6	0
,, ,, Pref. (£10)	9	12	6	9	15	0
Trinidad Central	2	0	0	1	11	3
Trinidad Leaseholds	1	2	6	1	0	0
United British of Trinidad		8	9		8	9
Ural Caspian		13	0		12	0
Uroz Oilfields (10s.)		11	6		8	0

Petroleum Products Prices. August 4.

Refined Petroleum: Water white, 1s. 2d. per gallon; standard white, 1s. 1d. per gallon; in barrels 3d. per gallon extra.
Motor Spirit: In bulk: Aviation spirit, 2s. 6d. per gallon; No. 1, 2s. 2d. per gallon; No. 2, 2s. per gallon.
Fuel Oil: Furnace fuel oil, £3 5s.; Diesel oil, £4 2s. 6d. per ton.
American Oils: Best Pennsylvania crude at wells, $3·00 per barrel. Refined standard white for export in bulk, 6 cents per U.S. gallon; in barrels 12 cents. Refined water white for export in bulk, 7 cents per U.S. gallon; in barrels 13 cents.

Dividends Declared by Mining Companies

During month ended August 10.

Company	Par Value of Shares	Amount of Dividend
Broken Hill South	£1	2s.
Chicago Gaika	10s.	5% less tax.
Consolidated Gold Fields	Pref. £1	6% less tax.
Electrolytic Zinc	Pref. £1	4%
Kalgurli	£1	3s. 6d.*
Kramat Pulai	£1	5% less tax.
Mond Nickel	Pref. £1	3½%
	Ord. £1	1s. tax paid.
Rambutan	£1	8d. less tax.
Rezende	£1	20% less tax.
South Kalgurli	10s.	1s. 9d. less tax.

* Second distribution of Assets.

PRICES OF CHEMICALS. August 4.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	0
,, 80%	,,	1	8	0
,, Glacial	per ton	60	0	0
Alum	,,	14	0	0
Alumina, Sulphate	,,	11	10	0
Ammonia, Anhydrous	per lb.		2	2
,, 0·880 solution	per ton	25	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	35	0	0
,, ,, pure	per cwt.	3	5	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	65	0	0
,, Sulphate	,,	16	0	0
Antimony, Tartar Emetic	per lb.		1	7
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	41	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			7
,, Chloride	per ton	22	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		1	11
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	13	0	0
,, Liquor, 7%	,,	4	10	0
Borax	,,	29	0	0
Boric Acid Crystals	,,	60	0	0
Calcium Chloride	,,	7	0	0
Carbolic Acid, crude 60%	per gal.		1	10
,, ,, crystallized, 40°	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		2	4
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100%	per lb.			10½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	8	10	0
,, Sulphate	,,	3	0	0
Lead, Acetate, white	,,	40	0	0
,, Nitrate	,,	46	0	0
,, Oxide, Litharge	,,	39	0	0
,, White	,,	41	0	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey 80%	,,	13	10	0
Magnesite, Calcined	,,	12	0	0
Magnesium, Chloride	,,	8	0	0
,, Sulphate	,,	9	0	0
Methylated Spirit 64° Industrial	per gal.		3	0
Nitric Acid, 80° Tw.	per ton	26	0	0
Oxalic Acid	per lb.			8
Phosphoric Acid	per ton	40	0	0
Potassium Bichromate	per lb.			6⅓
,, Carbonate	per ton	29	0	0
,, Chlorate	per lb.			5
,, Chloride 80%	per ton	12	0	0
,, Hydrate (Caustic) 90%	,,	32	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			9
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	6
,, Sulphate, 90%	per ton	15	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate 45%	,,	38	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			6
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	6	0	0
,, Chlorate	per lb.			3½
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 96%	,,	15	0	0
,, Phosphate	,,	17	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	15	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salts)	,,	4	10	0
,, Sulphide	,,	22	0	0
,, Sulphite	,,	12	10	0
Sulphur, Roll	,,	10	10	0
,, Flowers	,,	10	10	0
Sulphuric Acid, Fuming, 65	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 30%	,,	4	17	6
Tartaric Acid	per lb.		1	4
Turpentine	per cwt.	4	8	9
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	0
Zinc Chloride	per ton	20	0	0
Zinc Oxide	,,	42	0	0
Zinc Sulphate	,,	13	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Aug. 5, 1921			Aug. 4, 1922		
	£	s.	d.	£	s.	d.
RAND:						
Anglo-American Corporation	1	1	3	1	2	6
Brakpan	2	15	0	2	12	6
Central Mining (£8)	6	8	9	8	7	6
City & Suburban (£4)		3	0		2	6
City Deep	2	11	3	2	13	9
Consolidated Gold Fields		17	6		17	6
Consolidated Langlaagte		12	6		16	3
Consolidated Main Reef		10	6		15	0
Consolidated Mines Selection (10s.)		14	6		15	6
Crown Mines (10s.)	2	1	3	2	7	6
Daggafontein		3	6		3	6
Durban Roodepoort Deep		4	9		9	9
East Rand Proprietary		5	3		11	3
Ferreira Deep		8	6		7	9
Geduld	2	11	3	3	8	9
Geldenhuis Deep		5	6		7	3
Government Gold Mining Areas	4	3	9	5	7	6
Johannesburg Consolidated	1	5	0	1	8	6
Kleinfontein		6	0		9	3
Knight Central		4	3		5	3
Langlaagte Estate		14	6		18	0
Luipaards Vlei		2	9		4	6
Meyer & Charlton	4	11	3	4	2	6
Modderfontein, New (10s.)	3	15	0	4	2	6
Modderfontein B (5s.)	1	11	3	1	17	6
Modderfontein Deep (5s.)	2	7	6	2	8	9
Modderfontein East		12	6		8	6
New State Areas	1	2	6	1	13	9
Nourse		8	6		17	0
Rand Mines (5s.)	2	7	6	2	15	0
Randfontein Central		11	6		14	6
Robinson (£5)		10	0		8	6
Robinson Deep A (1s.)		8	9	1	3	9
Rose Deep		14	0		16	3
Simmer & Jack		2	6		3	9
Springs	2	0	0	2	7	6
Sub-Nigel		12	6		14	0
Union Corporation (12s. 6d.)		15	6	1	0	3
Van Ryn		11	9		12	9
Van Ryn Deep	3	15	0	3	12	6
Village Deep		9	6		14	6
West Springs		10	0		15	6
Witwatersrand (Knight's)		15	6		16	3
Witwatersrand Deep		8	6		16	6
Wolhuter		3	9		3	6
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		6	6		15	0
Transvaal Gold Mining Estates		7	6		14	0
DIAMONDS IN SOUTH AFRICA:						
Consolidated of S.W.A.		—			15	0
De Beers Deferred (£2 10s.)	11	0	0	11	15	0
Jagersfontein	2	7	6	2	12	6
Premier Deferred (2s. 6d.)	5	0	0	4	10	0
RHODESIA:						
Cam & Motor		8	9		14	0
Chartered British South Africa		11	9		14	6
Falcon		4	3		4	9
Gaika		10	6		10	6
Globe & Phœnix (5s.)		14	0		11	6
Gold Fields Rhodesian (10s.)		6	0		6	6
Loneiy Reef	2	5	0	2	5	0
Rezende	3	5	0	2	12	6
Shamva	1	12	6	1	10	9
WEST AFRICA:						
Abbontiakoon (10s.)		2	3		2	0
Abosso		8	0		7	6
Ashanti (4s.)		16	0		13	0
Prestea Block A		1	6		1	0
Taquah		9	0		6	6
WEST AUSTRALIA:						
Associated Gold Mines		2	9		5	9
Associated Northern Blocks		2	6		2	0
Bullfinch (5s.)		1	0		1	0
Golden Horse-Shoe (£5)		12	6		10	0
Great Boulder Proprietary (2s.)		6	0		4	6
Great Fingall (10s.)		1	6		1	0
Hampton Celebration		3	0		3	6
Hampton Properties		4	9		6	0
Ivanhoe (£5)		17	6		15	0
Lake View Investment (10s.)		8	9		9	9
Lake View and Star (4s.)		1	6		1	3
Oroya Links (5s.)		1	3		1	3
Sons of Gwalia		4	0		2	9
South Kalgurli (10s.)		7	3		8	0

GOLD, SILVER, *cont.*	Aug. 5, 1921			Aug. 4, 1922		
	£	s.	d.	£	s.	d.
NEW ZEALAND:						
Blackwater		2	6		5	0
Waihi	1	0	0	1	8	9
Waihi Grand Junction		8	9		10	0
AMERICA:						
British Platinum, Colombia		12	6		10	0
Camp Bird, Colorado		4	3		5	0
El Oro, Mexico		9	6		8	9
Esperanza, Mexico		17	6		13	0
Frontino & Bolivia, Colombia		6	3		10	0
Kirkland Lake, Ontario		15	0		10	6
Le Roi No. 2 (£5), British Columbia		2	6		2	6
Mexican Corporation, Mexico		—			7	6
Mexico Mines of El Oro, Mexico	4	5	0	3	7	6
Nechi (Pref. 10s.), Colombia		5	3		5	6
Oroville Dredging, Colombia	1	3	9	1	2	6
Ouro Preto, Brazil		7	6		14	0
Plymouth Consolidated, California		12	6		6	3
St. John del Rey, Brazil		13	6		18	6
Santa Gertrudis, Mexico		7	3		9	0
Tomboy, Colorado		5	0		10	0
RUSSIA:						
Lena Goldfields		8	9		6	3
Orsk Priority		5	0		5	0
INDIA:						
Balaghat (10s.)		8	0		8	3
Champion Reef (2s. 6d.)		1	0		4	3
Mysore (10s.)		11	3		13	0
North Anantapur		2	6		2	6
Nundydroog (10s.)		6	3		8	0
Ooregum (10s.)		12	0		14	0

COPPER:

	£	s.	d.	£	s.	d.
Arizona Copper (5s.), Arizona	1	7	6		18	9
Cape Copper (£2), Cape and India		12	6		7	6
Hampden Cloncurry, Queensland		5	0		6	3
Mason & Barry, Portugal	1	10	0	2	7	6
Messina (5s.), Transvaal		3	6		3	0
Mount Elliott (£5), Queensland		10	0		7	6
Mount Lyell, Tasmania		14	0		18	0
Mount Morgan, Queensland		12	6		12	6
Namaqua (£2), Cape Province		15	0	1	5	0
Rio Tinto (£5), Spain	30	10	0	28	10	0
Russo-Asiatic Consd., Russia		11	3		10	0
Sissert, Russia		7	6		4	6
Spassky, Russia		11	3		7	6
Tanganyika, Congo and Rhodesia	1	0	0		16	0

LEAD-ZINC:

	£	s.	d.	£	s.	d.
BROKEN HILL:						
Amalgamated Zinc		17	6		15	0
British Broken Hill	1	0	0	1	5	0
Broken Hill Proprietary	2	0	0	1	6	3
Broken Hill Block 10 (£10)		12	6		5	0
Broken Hill North	1	11	3	1	16	3
Broken Hill South	1	7	6	1	16	3
Sulphide Corporation (15s.)		12	6		11	3
Zinc Corporation (10s.)		10	0		11	6
ASIA:						
Burma Corporation (10 rupees)		7	0		6	6
RHODESIA:						
Rhodesia Broken Hill (5s.)		6	3		6	6

TIN:

	£	s.	d.	£	s.	d.
Aramayo Mines, Bolivia	1	17	6	2	6	3
Bisichi (10s.), Nigeria		5	3		5	6
Briseis, Tasmania		2	6		3	6
Chenderiang, Malay		13	0		11	3
Dolcoath, Cornwall			9			9
East Pool (5s.), Cornwall		3	9		3	0
Ex-Lands Nigeria (2s.), Nigeria		1	3		1	6
Geevor (10s.), Cornwall		3	9		3	3
Gopeng, Malay	1	12	6	1	15	0
Ipoh Dredging, Malay		11	3		7	6
Kamunting, Malay	1	5	0		16	3
Kinta, Malay	1	10	0	1	16	3
Lahat, Malay		10	0		6	3
Malayan Tin Dredging, Malay	1	6	3	1	2	6
Mongu (10s.), Nigeria		11	3		11	3
Naraguta, Nigeria		16	3		13	9
N. N. Bauchi, Nigeria (10s.)		1	6		2	6
Pahang Consolidated (5s.), Malay		6	0		5	6
Rayfield, Nigeria		2	6		2	3
Renong Dredging, Siam	1	6	3		18	9
Ropp (4s.), Nigeria		5	6		5	6
Siamese Tin, Siam	1	15	0	1	13	9
South Crofty (5s.), Cornwall		4	0		4	6
Tehidy Minerals, Cornwall		6	3		6	3
Tekka, Malay		17	6		17	6
Tekka-Taiping, Malay	1	1	3		18	9
Tronoh, Malay	1	3	9	1	10	0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

CHANCE'S COAL-FLOTATION PROCESS

In the MAGAZINE for August, 1918, some particulars were given of the method of floating coal from stone by delivering the coal as it comes from the breakers to tanks containing a pulp of fine sand and water. This semi-liquid has a specific gravity of 1·25, so that the coal will float and the dirt will sink. Particulars of installations using this system are described in the *Coal Age* for May 4, where D. C. Ashmead gives particulars of the plants erected at West Nanticoke and Beaver Brook, Pennsylvania, for the treatment of anthracite, and of plant of later design about to be erected.

The basic principle involved in the Chance process is that of producing by mechanical means a liquid the specific gravity of which is intermediate between that of coal and its accompanying impurities. In such a liquid, coal will float, whereas slate and "bone" will sink. As the specific gravity of coal itself varies somewhat, provision is made for altering the weight per cubic foot of the liquid to suit the quality of the material being treated. In order to obtain the desired results the machine utilizes a mixture of fine sea sand and water. The maximum specific gravity obtainable with these substances will closely approximate that of the sand itself, while it may vary from this down to unity or the specific gravity of the water used. The value actually employed will depend upon the nature of the coal to be treated and the allowable amount of bone to be shipped with the mine product. This apparatus consists of a cone-shaped receptacle containing the mixture of sand and water, the sand being kept from settling by the action of an agitator making 14 r.p.m. Water is fed to the machine through the refuse discharge pipe at the bottom of the cone, and make-up sand is pumped from the sand sump to a launder discharging into the cone top. At West Nanticoke (Fig. 2) the water flows upward through the cone at the rate of 6 in. per minute, and discharges from the overflow at the top at the same speed. Coal is fed by a chute to the top of the cone. The material is unsized—that is, it is a mixture of all sizes smaller than egg. Egg and larger coal is screened out of the run-of-mine, and after hand picking to remove large lumps of stone, goes to a set of crushing rolls. After being broken down it passes to the separator with the balance of the coal. The coal and light bone go over the overflow along with the surplus water rising through the cone. This product, with some sand adhering to it, then passes over a screen, where the coal is thoroughly washed with clean water and the sand is thus removed. Thence the coal is fed to a set of shaker screens, from which the various sizes made are sent to their respective pockets. Samples are taken from time to time, to make sure that no excess bone is included. Within the cone itself slate and heavy bone sink to the bottom and enter the discharge pipe. At the lower end of this pipe a slide gate communicates with a refuse chamber also provided with a gate at its lower extremity. When the upper valve is closed and the one at the bottom is open, it allows the rock to pass to a refuse pocket, from which it is removed by a dragline or scraper conveyor. As the refuse moves down the discharge pipe from the cone it is partly freed from sand by the action of the water moving upward to the cone through this passage. Some sand passes out through the refuse chamber, however, and when the waste material is discharged from the refuse pocket it goes over a small screen, where this sand is washed off. Thence the slate and rock are sent to the dump. Sand from the coal and slate screens is conveyed through pipes to the sand sump, being thus returned to circulation. In the sump the sand settles and is by this means separated from the surplus water. It is pumped back to the cone as needed.

From time to time tests are made on the specific gravity of the separating medium so as to ascertain whether it is being kept at the proper density. This test consists in placing balls of varying known specific gravities within the cone. If these test balls sink, sand is added to the mixture in the cone until it is brought to the desired weight per cubic foot. If they float more water is added. At West Nanticoke a 7 ft. 6 in. cone is installed. A 50 h.p. motor is connected to this machine, but from 11 to 16 h.p. only is normally consumed. This motor drives the agitator, the refuse conveyor, and the shaking screen. Another motor drives the sand pump. This is a 25 h.p. machine, but it operates at 20 h.p. Consequently, in all about 36 h.p. is required to drive the entire equipment.

The latest installation of one of these separators is at the Beaver Brook plant. The placing of this equipment, however, was not quite completed before the present suspension of operations throughout the anthracite region began on April 1 of this year. This machine has a diameter of 15 ft., or just twice that of the one at Nanticoke. A number of improvements also are embodied in its construction. Thus the discharge pipe is four times the diameter of the first one, and an interlocking device has been fitted to the upper and lower refuse gates, so that the two cannot be opened at the same time. Otherwise the contents of the cone might be allowed to escape. An accident of this kind is, of course, no fault of the machine, but the interlocking arrangement will tend to guard against human frailties. Another improvement is the introduction of pipes into the side of the cone, through which water may be forced to start or aid in starting the agitation of the sand should the machine be shut down for any reason. The refuse chamber on this machine is of larger size, so that its contents will not have to be emptied as frequently as was that in the earlier model. A small auxiliary chamber above the upper gate has a capacity of 1½ tons of rock and slate, and the main chamber will hold 4 tons of refuse.

The accompanying illustrations (see Fig. 1) show designs for a new type of preparation plant utilizing this kind of separation machine. In this plant the coal will be first dumped into the pocket (3). Thence it will be discharged by the feeder (4) on to the lump-and-steamboat shaker (5). From the deck of this shaker the coal will pass to the travelling picking table (7), where large pieces of rock will be removed, the cleaned product going to the crushing rolls (8). Coal going through the shaker (5) will pass to a shaking chute (6), thence to a spiral chute, after which it will join the crushed refuse roll (22) and be then returned by the conveyor or tower hoist and passed through the separator for re-treatment. The small refuse will be washed for the removal of sand, after which it will pass to the rock pocket (24). Sand from both shakers (21 and 23) will be taken by sand chutes to the storage pit (26). The make-up sand pump (27) removes this material from the sand storage pit or sump (26), delivering it to the make-up sand cone (28). The sand recovered by washing on the shakers (11, 12, 13, and 14) is conveyed by a sand chute (29) to the sand sump (30), from which it is taken by the

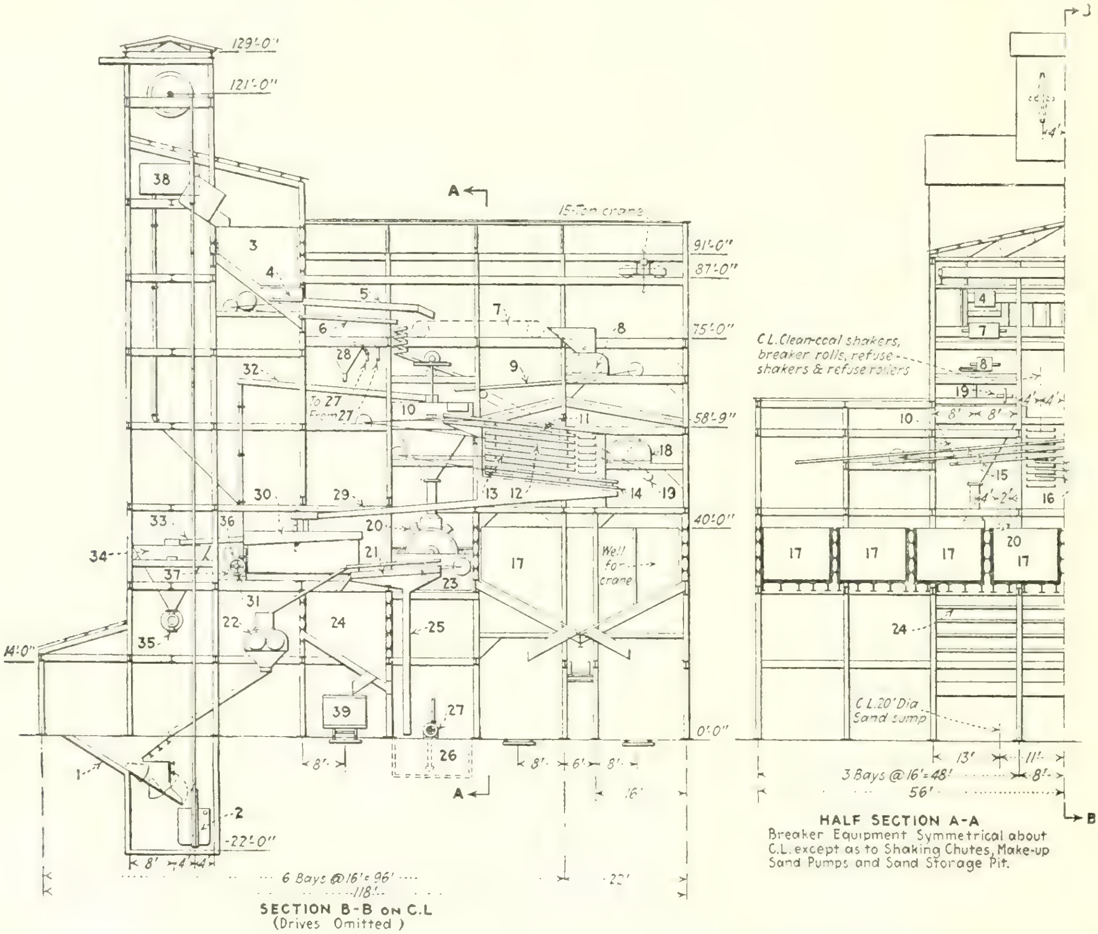


Fig. 1.—Elevations of Latest Design of Chance's Coal-Flotation Plant.

coal from the rolls (8) moving in the chute (9). By this latter chute it will be delivered to the washing cone (10). The clean coal overflowing from this machine will go to the bank of shakers (11, 12, 13, and 14) to be sized. Broken coal passing off the top of these shakers will go to a set of rolls (18) and be crushed, after which it will be taken by the conveyor (19) and by it delivered to the cone for retreatment. Sized products from the various other decks of the shakers will pass by means of shaking chutes (15, 16, etc.) to their proper pockets. Rock from the refuse tank below the cone will be removed and discharged to a shaker that will separate all pieces above chestnut size. This will go to the sand pump (31) and delivered to the cone for use. This sand passes through the pipe (33). Overflow from the sand sump (30) passes to a culm settling cone (34), from the bottom of which the culm is discharged. Water from the cone goes to a sump, from which it is returned by a pump (37) to the water tank (38).

The author proceeds to give the results obtained by this process at Nanticoke (Fig. 2). This plant was placed in commercial operation in October, 1921, and with the exception of the month of January, was continuously operated until April 1, when the strike began. During a portion of November and throughout practically the whole of December

the plant was operating two shifts per day, the day shift working on freshly mined coal for a part of the time and during the rest of the day on bank material. During the night the plant ran entirely on material from the bank. During this entire time only one shut-down was caused by the breaking of the washing machine or any part of its mechanism. This delay was caused by the failing of the bevel gear by which the revolving agitator is driven. A stoppage of the water supply by river debris caused a cessation of agitation, and it was this clogging of the cone to which the accident should be ascribed. As before stated, this machine is 7 ft. 6 in. in diameter and when washing bank material its capacity is limited only by the speed with which the slate can be trapped out through the slate valves. It has been found to treat an average of 25 tons per hour. On two occasions capacity tests have been conducted when operating on culm-bank material. In both cases approximately 62 tons gross of bank coal were passed through the machine per hour. A fully loaded railroad car of coal was delivered by the machine in two hours without overfeeding. If the machine is fed at a more rapid rate than that at which the refuse can be withdrawn, slate accumulates in the lower portion of the cone and it becomes necessary to stop the feed until this accumulation can be trapped out. From 5 to 15 minutes is consumed in removing such an accumulation. Were the plant equipped with an automatic feeder, such overfeeding would not occur. After the operatives have become familiar with the capacity of the machine, however,

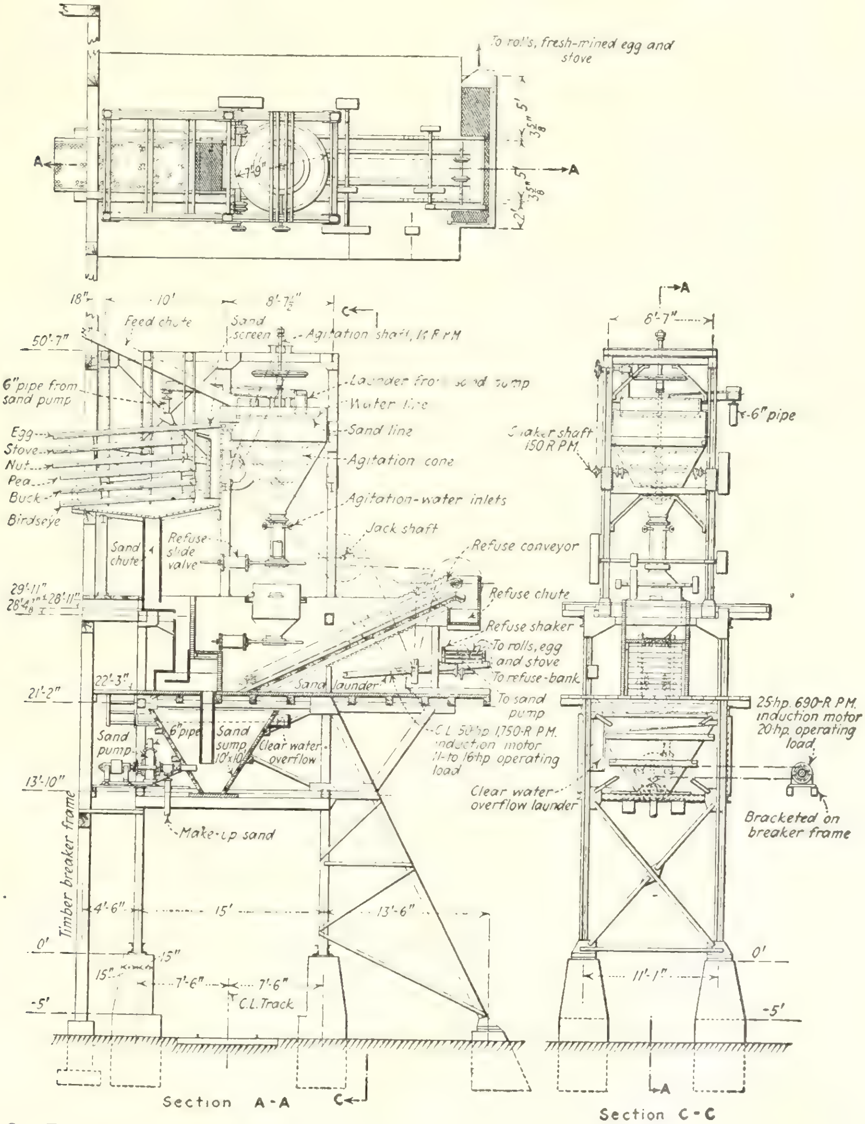


FIG. 2.—PLAN AND ELEVATIONS OF CHANCE COAL-FLOTATION PLANT AT WEST NANTICOKE.

trouble from this cause has been rare, and a feeder such as has been suggested has not been deemed necessary.

The capacity of this machine when working upon freshly mined coal, as shown by its operation through the period above mentioned, appears to be between 50 and 60 tons of feed per hour. The output of the mine furnishing coal to this plant being relatively small, few opportunities have been afforded to determine the maximum capacity of the machine by continuous feeding at high rates over long periods of time. When running on freshly mined coal, the overflow capacity of the machine is a factor as well as the rate of discharge of dirt. This, with the type of overflow employed at this plant, seems to be about 50 tons of clean coal per hour. By the introduction of a scraper, or a coal wheel, the rate of discharge can be materially increased. If such a device were added to the machine, its capacity would be limited only by the amount of slate or refuse that could be removed through the discharge pipe. The overflow type of discharge was employed at this plant because it breaks the coal less than do mechanical devices. With the overflow discharge the coal actually slides out of the machine on to the shakers.

At the Beaver Brook plant no tests have been made, as this installation has just been completed, its operation being prevented by the suspension of work on April 1. However, on the day prior to the suspension, sand was placed in the cone and was readily agitated and the separating medium brought to the proper specific gravity. Although the contents of this machine weighed 120,000 lb., it was readily livened up to the desired consistency.

By the use of this process the degradation or comminution of the coal is much lessened. The distance through which the coal must travel before it finally comes to rest in the coal pocket is much shorter than in the ordinary washery. Furthermore, in sizing the coal at the head of the building, the small particles act as a cushion for the larger ones. The complete elimination of jigs also reduces breakage appreciably. In this machine the material is not, as in jigs, caused to alternately rise and fall. Consequently the abrasion of one particle of coal by another is greatly lessened. Furthermore, the delay in sizing the coal till the rock has been removed from it still further reduces breakage.

This process requires much water. At West Nanticoke it is possible to draw this from the Susquehanna River. The water in this stream is low in acid and consequently it corrodes but little the lining of the separator. Should these machines be installed in localities where a copious supply of fresh water was not available and mine water had to be used, the effect of acid on the tank and parts of the machine might be serious. However, this difficulty could be met in many ways. Thus the water could be treated with lime and the acid neutralized, or the parts of the machine exposed to the action of the water could be made of bronze, cast iron, or some non-corroding metal. The sand, of course, has an abrasive action when agitated, but this is not serious and may be readily overcome.

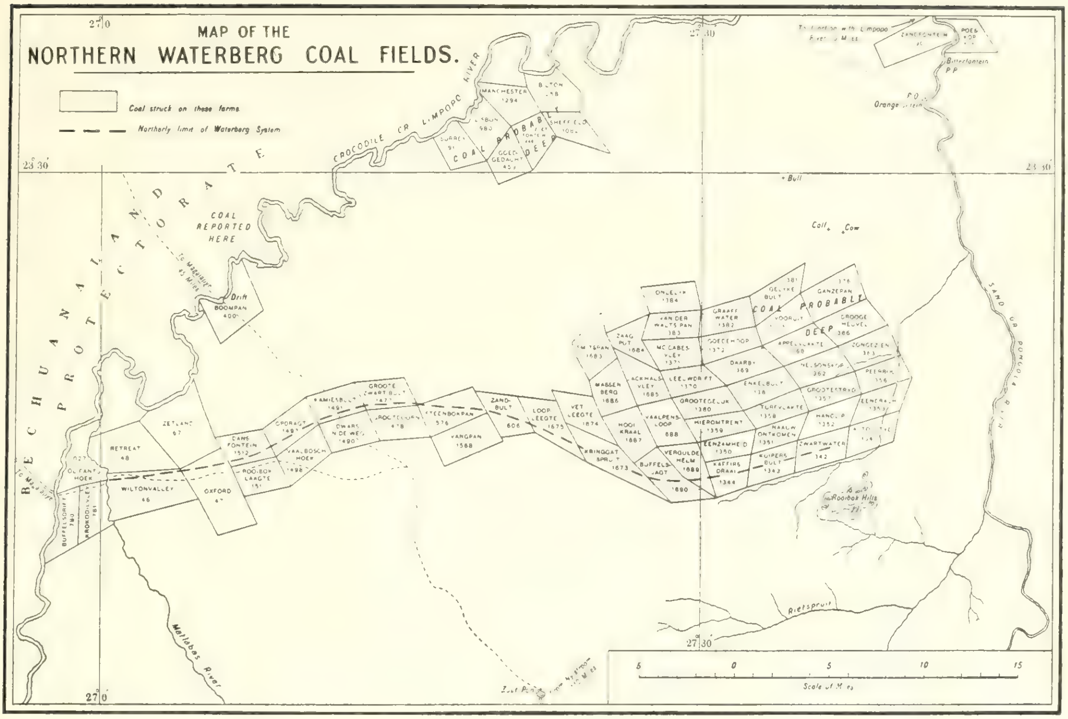
So far as the author has been able to learn, investigations already conducted would indicate that nothing will interfere with an extended utilization of this process. It promises to cheapen the cost of production, decrease the amount of capital invested, reduce the number of men employed, improve the product, and increase the return because of lessened degradation. It would appear to have like advantages in the cleaning of bituminous coal.

COAL IN NORTHERN TRANSVAAL

The *South African Journal of Industries* for April publishes an article on the new coal discoveries in the Waterberg district of the Northern Transvaal, written by T. G. Trevor, Inspector of Mines, and A. L. Du Toit, of the Geological Survey. These deposits are in the extreme north, in the angle between the Limpopo River and its tributaries, the Pongola to the east and the Matlabas to the west. In March, 1920, coal was reported as having been struck in thick seams on Grootgeluk, and subsequently on adjoining farms. (See Map.) On a geological reconnaissance being made it became apparent that the coal-bearing formation stretched over quite a large area. It was later arranged, in conjunction with the Mines Department, that a shot-drill should be sent up in order to prove the coal, and that the core obtained should be properly sampled and analysed. Since that date a considerable amount of knowledge has been accumulated, and it now appears that in this area there exists a coalfield second to none yet proved in South Africa.

Northwards from the low ridge of Waterberg sandstone making the Rooibok Hills, there extends to the Limpopo a very gently undulating bush-clad tract, the only elevations consisting of the four curious-looking spikes of Bushveld sandstone, standing up about 60 ft. at the most, of which Nelson's Kop lies nearest to the coalfield. With the exception of these, and of a few outcrops, mostly within pans or along the bounding rivers, the solid geology is concealed by a mantle of reddish sand. Sufficient, however, is now known from the bore-holes to enable the general geological structure and the distribution of the geological divisions to be determined, excepting across the northern and western sections, which have not yet been drilled.

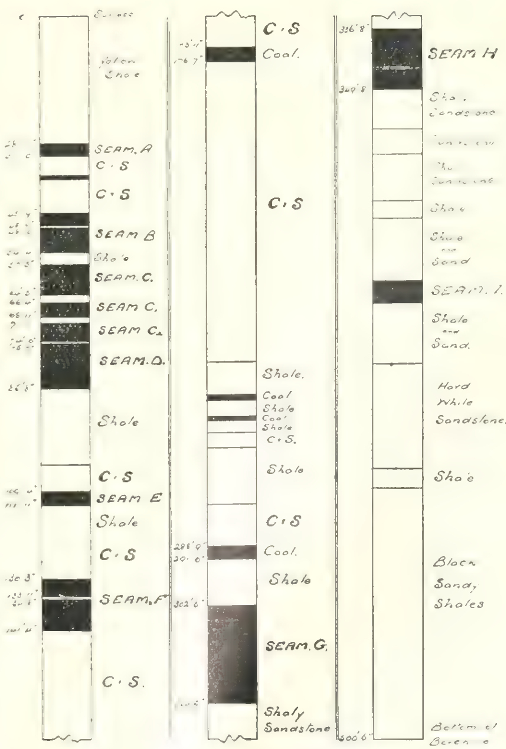
The southern limit of the coalfield is distinctly ascertained as the boundary is due either to a fault throwing the coal measures down against the Waterberg series, or to a strong unconformity, causing the former to overlap upon a northward-dipping slope made by the older formation. In the coal area the Karroo beds are lying nearly flat, but along the right bank of the Limpopo, below its junction with the Matlabas, the coal-measure grits have been disturbed and sometimes are dipping at angles up to as much as twelve degrees. With Grootgeluk as centre there is an area about 4 miles in diameter, where soft bluish shales are either exposed or are to be seen as fragments in the soil, and beneath which the coals occur at a very shallow depth. To the north-east the coal measures must pass beneath the higher geological horizons, and the seams have not been struck in the bore-holes beyond the line adjoining the farms Van der Walts Pan No. 1383 and Grootstryd No. 1357. Judging from the information available, the coals, if present underground, would be too deep for economic



mining between Engelbult No. 1361 and the Pongola River, the strata overlying them consisting of the Bushveld Sandstone series and the Amygdaloidal Basalts; the latter make only a small "basin" upon Goodehoop No. 1372, Daarby No. 1369, and Appelvlakte No. 1368. The red marls that normally should intervene between the coal measures and the Bushveld sandstone are absent hereabouts so far as can be judged, although represented to the north-west at Slypsteendrift on the Limpopo. This would indicate an unconformity between the Bushveld sandstone and the coal measures, an important factor to be reckoned with in the proving of the areas further to the east and north.

For the present it can be said that coals have been recorded in every one of the bore-holes over a continuous area of 35 square miles; the limits that have hitherto been proved are given by the lines joining the centres of the farms Turfvlakte, Hooikraal, Smitspan, and McCabe's Vlei, but a considerable extension towards the north-west is almost a certainty. Over the area thus proved the sections of the strata passed through are generally concordant, but further boring with a core drill would be necessary to enable the individual workable seams to be identified upon those farms where the strike has as yet been made with the jumper machine alone.

The 500 ft. bore-hole on Grootgeluk, while not piercing the whole of the Karroo strata, proved toward their base 62 ft. of black barren shales, which have been correlated with those of the Lower Ecca series that underlie the coal measures in Natal, and which have also been recorded from bore-holes near Palapye in the Bechuanaland Protectorate, just above the glacial conglomerate. Next come



A Characteristic Bore-Hole.

about 120 ft. of sandstones, with which is associated a lower group of seams; above that a continuous series of alternating thin coals and black shales, 280 ft. in thickness, in which no less than 113 ft., or two-fifths, are actually coal; towards the top of these is the upper group of seams overlain in turn by barren shales. A section is reproduced on the previous page.

From the few fossil plants obtained from certain of the carbonaceous shale intercalations, it can be concluded that the coal-bearing beds are to be correlated with the coal measures of the Transvaal and Natal, and that they represent the Middle Ecca series of the Karroo system.

Analyses of the coal show the upper seams to be bituminous but high in ash, so that the coal will be more suitable for carbonizing than for burning in grates. The deeper coals are higher in fixed carbon and lower in volatile contents, and are not quite so high in ash as those above. Generally speaking these deeper coals resemble the coals of Witbank and Natal.

Underground Haulage at Modder East. — The April *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa contains a paper by John Chilton on the endless rope haulage at Modder East. The adoption of this system is, in a way, a reversion to the methods well known for many years in English coal mines; but as it is a novelty in gold mining, the installation deserves notice.

The installation described is in operation at the Cloverfield Shaft at Modder East, and is about 2,500 ft. in length. Before the installation of the system the ore from the stopes and development drives was dealt with by air and electric winches, but it was found that this method was too slow and costly for a permanent plant, and other methods of dealing with the ore had to be considered. The problem to be solved was to find the best method of raising 1,000 tons of rock or ore per shift from the stopes and drives on the dip side of the main shaft, the upper landing being 470 ft. vertically above the lower one. The average dip of the incline is about 13°, but near the bank-head this becomes steeper, rising to 17°.

After it was decided that an endless rope haulage would be the best means of dealing with the requirements of this section of the mine, the question arose which was the best method of attaching the cars to the rope. On the mines of the Witwatersrand, and particularly in the East Rand section, there are numerous types of rope-clips in general use, and many of them have distinct merits, while none are absolutely safe. With the ordinary clip of the lever or screw principle, when ascending a slope, there is always the danger that the full trucks will occasionally break away and slip down the rope when nearing the top of a steep incline. This is due to the fact that the full rope near the bank-head is of slightly less diameter than the same rope at the bottom of the slope, consequently most rope-clips have to be tightened up when under this heavy strain. This entails extra expense in labour, and often damages the rope. To avoid these dangers and disadvantages at the Modder East it was decided to put in the chain grip attachment. This method of fastening is probably the simplest that could be employed, and where there is a steady and even pull against the load it cannot be surpassed. Subsequent events have shown the wisdom of this choice, for neither with the full nor the empty car has trouble been experienced due to slipping. The chains are attached to the front of the full car, and to the back of the empty. They are about 10 ft. in length, with three-eighth links, and have a hook at each end. One hook is attached to the drawbar of the truck, and then the chain is wound a few times round the rope and hooked back upon itself. One of the chief merits of this method of fastening is that the pull is on the drawbar, low down, and in the centre of the road, thus avoiding the side wear on the wheels, which is so marked a feature in some forms of endless rope haulages. The grip is also self-tightening, and does not damage the rope. When the chain grip was under consideration, it was recognized that there might be some trouble due to the twisting of the rope if great care was not exercised in splicing the ends, but this drawback was successfully overcome, and after the first few cars were drawn up no further trouble was experienced from this source. Although there are two curves in the haulage, the chains and hooks pass round the sheaves without difficulty. The breaking strain of the chain is about three tons, and should a truck become derailed the chain breaks, thus avoiding damage to the rope. The diameter of the rope is ⅞ in., and it travels over the tracks at the rate of two miles per hour. The attaching and detaching of the trucks at the three landings is done without interfering with the speed of the rope.

The haulage engine is driven by a 236 h.p. motor. This gives enough power for present-day use, and admits of further extension of the haulage should this be desirable. There is sufficient brake power on the engine to stop the haulage in 10 ft. in the event of derailment of cars or other accident. The rope passes three times round the slightly-coned drum; this gives sufficient friction to prevent slipping, while it allows a twisting movement in the coils. Trip switches are fitted to guard against overloading and consequent damage to the motor.

On the haulage way there are four landings or points where trucks are fastened on and taken off. The main station is on the nineteenth level, and it is at this piont that all trucks are dealt with. The track from the bank-head to the tipplers has a 3% grade, and trucks released from the rope run out by gravity. Empties return to the hanging-on point by the same means. The landing at the twentieth level is laid with a turn-out left and right, and trucks proceeding south pass along a drive under the haulage. Empty cars are detached on one side, and full cars are connected up on the other. Switches are laid from the main track and, when necessary, a car is switched in, unhooked, and sent in the desired direction. A slight twist and a shake is sufficient to release the grip on the rope, and one native is all that is necessary to deal with the empties. On the opposite side of the track two natives attach the loaded cars. On the twenty-first level there is only one drive on the south side of the haulage way, so a somewhat different arrangement was necessary. Empties required at this station are switched out and move over a bridge which spans the main tracks, passing along to the siding about 200 ft. distant. At both stations the full track is slightly dished to allow the loaded cars to pass under the rope, when attachment is

easy. Ore from the twenty-second level is dropped through a vertical winze to a lower level and is loaded up from a foot-wall cross-cut and attached to the rope at the twenty-third landing. Empties required in the north drives are switched in that direction; the remainder pass along to the main landing, where they are detached from the rope. There is a slight depression and deviation of the full track near the top. This was found necessary in order to remove the weight of the rope from the car when passing over the bend from the slope into the level landing. The curves on the haulage way are fitted with white iron pulleys, the lower flanges of which hold up the rope so that chains and hooks pass round without knocking or excessive friction.

Trucks loaded with timber, drills, and other mining material pass freely up and down the haulage. When loading up explosives special precautions are necessary. The truck containing explosives is first fastened on to the rope, and about 10 ft. behind the guard-truck is connected up. This acts as a buffer should a car be accidentally detached after running over the runaway switch. Fortunately this misadventure has not yet occurred, but still it might happen. Special trucks for carrying men are in use. These are fitted with double chains and a safety trailer. The truck immediately before the man truck has also this safety appliance to prevent runaways. Owing to the slow rate of motion of the haulage, it is quite easy to leave the conveyance while in motion so that accidents through travelling up and down are not likely to be numerous.

Trucks are attached to the rope at fairly regular intervals. The lowest landing spaces the cars every 80 ft.; the next station attaches a truck between these; and the upper landing again divides this distance; so that the trucks reach the top about 20 ft. apart. With this interval between each car, the detaching of the rope is easily accomplished. Sometimes cars are sent up with only the length of the attachment chain between them; this is bad practice, but it causes no inconvenience to the natives employed releasing the cars. The capacity of the haulage is about 1,000 tons in eight hours. This figure has not yet been reached, but 90 trucks per hour has been accomplished over a consecutive period of six hours, and there is little doubt that with greater experience and larger supplies of ore the desired tonnage could be easily dealt with.

The succesful working of any endless rope haulage system is governed to a great extent by the arrangements for taking in slack rope and keeping sufficient tension to prevent slipping on the driving pulley or drum. Ropes stretch with use, and the weight of the load varies. The grip on the driving wheels slackens or tightens according to the position of the cars on a haulage way of varying grades, so that some method of keeping an even tension on the rope must be employed. On this system, the tension weight is at the lowest point in the haulage, and consists of a loaded bucket containing about three tons of scrap iron. This moves between pulleys, and its average travel is less than 12 in. To prevent violent surges due to serious accidents on the haulage, the balance weight itself is fitted with anchoring ropes which allow of a small movement beyond the ordinary travel of the tension weight.

The haulage is laid with 30 lb. rails in 30 ft. lengths with fish-plated joints, and a 2 ft. 6 in. gauge. It was originally laid with steel sleepers, but these were found to be unsuitable, and have been replaced by wooden ones. The trucks used are the standard Rand Mines iron truck, with a carrying capacity of one ton. They are fitted with Rowbotham wheels, have a wide wheel base and substantial drawbar, and the centre of gravity is low so that derailments are reduced to a minimum. Though the trucks on the haulage system only move at a very low speed, safety measures and appliances have not been overlooked. To guard against the possible danger of runaway cars various devices such as cut-outs, runaway switches, and kick-ups were installed. The haulage way is lighted up from end to end and a roped-off travelling way has been made by the side of the empty track, and electric bells and telephones are in use at every landing. The immunity from accident which the haulage has so far experienced testifies to the effectiveness of these safety measures.

The system at the Modder East has not been long enough in operation to enable a close estimate of costs to be made. The life of the rope has not yet been ascertained, neither has the system been run to its full capacity, but the saving on the previous method is most marked, both power and labour showing considerable reduction. In working the haulage only fourteen natives and one European are employed. After allowing a reasonable interest on the capital expended, the cost per ton mile does not exceed 3·1d.

Lead-Copper Mattes.—British Patent 16,163 of 1921 (181,239), issued to F. E. Elmore and the Chemical and Metallurgical Corporation, describes the application of the Elmore acid-brine process to the separation of the sulphides contained in complex matte. The Elmore patents dealing with the main process were given in full in the MAGAZINE for August, September, and October, 1919, and December, 1920. We quote the specification of the new patent herewith.

The invention relates to the treatment of lead-bearing mattes and similar products consisting of metallic sulphides obtained by fusion. It is particularly applicable to the treatment of leady copper matte, that is, matte consisting of sulphides of iron, lead, copper, and zinc. It is also applicable to the treatment of arsenical lead-bearing mattes. The object of the invention is to extract the lead, the presence of which in such materials offers difficulties in their metallurgical treatment. The invention is based upon the discovery that the lead existing in lead-bearing mattes is extractable by means of the acid-brine process described in British Patent No. 127,641 (see the MAGAZINE for August, 1919).

According to the present invention the matte is pulverized and treated with a hot, strong, preferably saturated solution of sodium chloride, or other suitable chloride to which a sufficient proportion of hydrochloric acid, sulphuric acid, or alkali bisulphate is added. Under these conditions practically the whole of the lead passes into solution, accompanied by part of the silver (if any) present. The other metallic sulphides present remain for the most part unattacked in the residue. The hot solution is separated from the residue by filtration or decantation and may if desired be treated by known methods for recovery of the metals dissolved therein or for purification of the chloride solution preparatory to its being used over again. The residue, when washed free from soluble

chloride, is in suitable condition for metallurgical treatment by known methods.

Suitable chlorides for use in carrying out the invention are the chlorides of sodium, potassium, calcium, magnesium, and ammonium. If calcium chloride be chosen it is preferable to use hydrochloric acid as the acid agent in order to avoid the formation of calcium sulphate. Preferably the chloride solution is used at the boiling point and the acid or bisulphate is added gradually. The proportion of acid or bisulphate required varies with the composition of the matte, and is easily ascertained by a small preliminary test or by an analytical control of the operation in the known manner.

In the first example given in the specification, a leady copper matte containing the following constituents in percentages is used: lead 17·60, copper 5·86, zinc 3·8, arsenic 0·06, antimony 0·36, iron 42·15, silver 0·17, sulphur, etc., 30·00. The matte is pulverized to pass through a 100-mesh standard sieve; 100 kilos of the pulverized material are mixed with 1,200 litres of a hot, saturated solution of common salt, and 24 litres of sulphuric acid of specific gravity 1·84 are gradually run in. The mixture is then agitated and heated at about the boiling point until practically the whole of the lead has passed into solution, the time required being about 1 hour. The undissolved residue is now separated from the hot liquor by filtration, decantation or the like, washed free from soluble chloride and dried, when it is found to contain about 0·5% of lead.

In the second example a leady copper matte containing 24·9% Pb, 8·5% Cu, and 9·8% Zn (the balance being iron, sulphur, etc.) is pulverized to pass through a 100-mesh standard sieve and 100 kilos of the pulverized material are treated with 1,200 litres of a 35% solution of calcium chloride and 180 litres of hydrochloric acid of specific gravity 1·16 for half an hour at the boiling point. The undissolved residue, when separated and dried as in Example 1, is found to contain about 1·2% of lead.

Arsenical mattes may be treated in a manner similar to that indicated in the foregoing examples, special care being of course taken to prevent injury to the operator owing to any emission of volatile arsenic compounds.

Titanium White.—The *Journal* of the Royal Society of Arts for June 23 contains a full report of a lecture by Noel Heaton on the use of titanium oxide, with or without association with barium sulphate, as a white pigment. Note of this lecture was made in our June issue.

After giving a history of general knowledge on titanium, and of the work done by Jebsen and Farup in Norway and Rossi and Barton in the United States, with a view of removing titanium oxide from titaniferous iron ores, the author proceeds to describe the investigations into the use of such ores for the purpose of producing titanium oxide suitable as a white pigment. He then deals with the product now manufactured in Norway, and offered on the market.

The titaniferous ore found near Egersund, south of Stavanger, consists mainly of a variety of ilmenite, to which the formula Fe (Mg) $TiO_3 + 10\ Fe_2O_3$ has been assigned, together with associated minerals, principally magnetite, hypersthene, and apatite, with a small quantity of vanadium. This crude ore is first freed from these associated minerals and impurities by mechanical treatment at the mines, and the concentrate, which contains titanium oxide to the extent of 47·5% is sent to the factory for treatment. The first process in the manufacture is to reduce the concentrate to a state of fine powder by pulverization in a ball-mill. This powder is then mixed with concentrated sulphuric acid to the consistency of paste. On heating this mixture a violent reaction commences, which once started proceeds exothermically, with the result that the mineral is entirely decomposed and converted to a mass containing soluble sulphates of iron and titanium, which sets up into the form of a hard cake. This cake, or "coagulated mass," as it is technically termed, is then reduced to powder by means of a disintegrator and extracted with water, a solution being thus obtained of iron and titanium sulphates. Owing to the fact that the salts of titanium are very unstable, these having, in fact, as much tendency to act as an acid as a basic radicle, on heating this solution nearly to boiling point for some hours, the titanium sulphate breaks down and titanic acid is thrown down from the solution as a white precipitate leaving the ferrous sulphate in solution. By this means the titanium can be completely separated from the iron, all that is necessary being to subject the precipitate to a thorough process of washing. Owing to the fact, however, that the precipitate of titanic acid is in such an extremely fine state of division that it will pass through any filter cloth, the ordinary method of collecting and washing the precipitate by means of the filter-press cannot be employed, and the more costly and elaborate method of washing by decantation has to be resorted to.

If the pulp thus obtained after removing as much water as possible by this means is merely dried an amorphous product is obtained, consisting of titanium hydrate with a small proportion of acid sulphate of titanium and free sulphuric acid. This product does not form a reliable pigment as its opacity is not fully developed, and being a hydrate, it is not perfectly stable in presence of organic bodies, such as linseed oil. In order to develop the physical condition required, the pulp is, therefore, passed into a rotary furnace of a type similar to that used for cement, where it is in one operation dried and calcined to a high temperature. By this means the titanic acid is converted to anhydrous titanium oxide and changed from the amorphous state to a crypto-crystalline condition. The titanium oxide comes out of the furnace in the state of small friable nodules, which are finally pulverized and converted into an extremely fine powder by a process of air flotation.

The manner in which the calcination process is carried out is of great importance, and careful control is necessary. It is essential to carry it far enough to convert all the titanium from the amorphous to the crystalline condition, but at the same time it must not be carried too far, otherwise crystalline form as well as structure will be developed, which would ruin the product by rendering it gritty. The essential point is to change the internal structure of the particles without altering the size and shape in which they are precipitated. It was found by experience extremely difficult to control the reaction to this nicety on the large scale if a precipitate containing pure titanium oxide were employed. In order to prepare the titanium pigment — which is known as "titanium white" to distinguish it from the pure oxide—further modifications in the process of

preparation were found necessary. It was found that by precipitating the titanium together with barium sulphate a physical combination of the two is formed, which is more easily controlled on calcination than the pure oxide and, at the same time, is very much more economical to produce. It has been found that the most efficient combination of these two substances for most purposes is that containing one molecule of titanium oxide in combination with one molecule of barium sulphate or, by weight, titanium oxide 26·5% and barium sulphate 73·5%. Pigments containing a higher or lower percentage of titanium can, however, be produced at will.

In practice the pigment is produced in two strengths—one containing the two materials in the above proportions—roughly, 25% of titanium oxide, which is the standard product. The other, which is used for special purposes, contains a much lower proportion of barium sulphate, and the maximum content of titanium which can be satisfactorily used.

Theoretically, one would imagine that the best way to form this combination would be to precipitate the titanium and barium simultaneously, but in practice there is a risk of bringing down some of the iron if this is done, and it is found preferable to form the barium sulphate first and add it in the state of pulp to the solution and precipitate the titanium on it. After the combined precipitate has been washed free of iron and before it is transferred to the furnace, a small proportion of barium carbonate is added to it in order to ensure that every trace of free sulphuric acid is neutralized by conversion into barium sulphate, as this would obviously be objectionable in the pigment.

The pigment as produced by this process in the early days was not quite perfect in colour, having a yellowish cast, which, at the time, was attributed to the fact that the iron was not entirely removed. It was found, however, that after taking every possible precaution to free the product from the least trace of iron, it was impossible to prevent it turning slightly yellowish in colour during the process of calcination, and it was eventually discovered that the very natural assumption that this discoloration was due to a trace of iron was, as a matter of fact, incorrect. As a result of research, it was proved that it was due to a molecular change which takes place in the pigment during the process of calcination. By calcining the titanic acid to a sufficiently high temperature for a sufficiently long time, it is possible, in fact, to develop in it clearly defined rutile crystals of a distinctly yellowish colour. The problem then arose how to prevent this change taking place, and this entailed a large amount of research before a remedy was discovered. If a small proportion of the titanium is present in the form of phosphate, the change is, for some reason which it is difficult to understand, entirely prevented, and a perfectly white product obtained. This discovery has only been made comparatively recently, with a result that the pigment as produced to-day is vastly superior in quality.

Titanium white as thus produced has chemical properties which render it of great value as a pigment. Owing to the fact that titanium oxide, like silica, is a chemically stable compound, the pigment is extremely resistent to attack by any of the destructive agencies to which it is likely to be exposed. It will resist the attack of sulphuric acid, and it is not liable to discoloration by sulphuretted hydrogen because titanium does not readily form a coloured sulphide. Being also a fully oxidized body and in the crystalline state, it is not readily attacked by sea air or salt water.

Lead-Zinc Deposits in North-West Territory.—In the *Canadian Mining Journal* for June 9, C. B. Dawson gives some account of zinc-lead deposits to the south of Great Slave Lake.

In 1914 a prospecting party was sent by an English syndicate to examine the country near Great Slave Lake. This party staked a number of claims to cover some lead-zinc deposits which they found about 10 miles south of Pine Point, on the south shore of Great Slave Lake. As it was then late in the season, little work was done, and the conditions arising from the war prevented a detailed examination until 1920 and 1921, when the writer, with a small party, did a considerable amount of stripping and test-pit sinking.

The claims are situated in almost flat country, about 200 ft. above Great Slave Lake, to which the descent is imperceptible, save at a point about two miles back from the lake where some low shaley limestone ridges provide a slight local relief. The country consists for the most part of sandy or bouldery plains, interspersed with swamps and muskegs and very low esker-like ridges of gravel or sand. The prevailing timber is Banksian pine, with which is associated in minor amount white and black spruce, tamarack, aspen, balsam-poplar, and birch. The soil is almost invariably poor and unsuitable for a heavy forest growth.

The underlying rock of the district consists of dolomite (locally described as the Presqu'ile formation) belonging to the Middle Devonian. Judging by the few exposures between the claims and Great Slave Lake, this dolomite passes downward into shaley limestone and bituminous shale, which may represent the lower measures of the same phase of the Middle Devonian or the upper part of the formation below, namely, the Pine Point limestone.

The lead-zinc deposits so far discovered occupy the eroded crests of what are considered to be low anticlinal folds. Their outcrop is characterized by sink-holes which, in the case of three or four deposits, almost completely surround the ore, and in general appear to mark its surface limitations. The visible sink-holes are obviously post-glacial in age. Whatever their origin, it would seem clear that there is some connexion between their occurrence and the pyritic outer portions of the lead-zinc deposits. Their maximum depth below the general level is about 20 ft. Where the deposits are capped by barren dolomite, or dolomite low in lead and zinc, or by boulder-clay, the surface, apart from the sink-holes, gives no indication of mineral deposits beneath. Where, however, the ore actually outcrops, there is no vegetation, and the surface is covered by a crumbly gossan throughout which cubes of galena are thickly scattered.

The minerals of the deposits are galena, zinc blende, marcasite, and pyrite, together with the oxidation products of these minerals. Oxidation was evident at the greatest depth reached in a prospect shaft, namely, 32 ft. While the mineralization commonly follows the bedding planes of the dolomite, increasing and weakening horizontally, irregular lenses of ore cross the strata at every angle, and bunches of similar material occur irregularly throughout the dolomite. The

knowledge so far gained would seem to indicate that the deposits are roughly circular or elliptical in horizontal cross-section, and that as regards mineralization, lead minerals predominate over zinc towards the centre, and at depth the galena and blende become intimately mixed. The depth of the deposits is as yet unknown, but it is believed to be considerable, and to be limited only by the depth of the Presqu'ile dolomite at the claims. Near the south shore of Great Slave Lake this dolomite is about 200 ft. thick.

Sufficient data are not yet available to correctly estimate the ore so far developed; but a close approximation will place it in the neighbourhood of one million tons, as determined by the prospect shafts. Channel assays taken from all parts of the deposits average 30% lead and zinc, with a silver content of 1·5 oz. per ton.

Transport difficulties are the only hindrance to the immediate development of the property; but conditions are rapidly becoming better. With the completion, recently, of the Alberta and Great Waterways Railway there is now direct communication between the rail centre of Edmonton and Fort McMurray, the beginning of the great water route to the Arctic Ocean. This water route, via Athabaska River, Athabaska Lake, Slave River, and Great Slave Lake, gives, save for a 16 mile portage at Fort Smith on the Slave River, uninterrupted communication to the deposits.

Test for Uranium.—In the *Journal of Industrial and Engineering Chemistry* for July, H. D. Buell describes a new test for uranium. In testing slags and ores containing or supposed to contain uranium, it has been found that when uranium is present zinc, added to a nitric acid solution of the material, gives a yellow deposit on the zinc. The test is simple in manipulation and requires no special caution in regard to acid strength and temperature. A nitric acid solution of the sample is prepared. A large excess of acid is to be avoided because the reaction may become so violent as to boil out of the test tube and an unnecessary amount of zinc will be consumed. An excess of granulated zinc is added to the solution and the reaction is allowed to proceed until the acid is spent, when a yellow deposit appears on the zinc. If the reaction is too violent the acid may be diluted; if too slow, more acid may be added. The yellow colour develops more rapidly as the concentration of uranium is increased, but always appears when the reaction completely stops. The same yellow deposit is obtained from an aqueous solution of pure uranyl nitrate crystals, with no free acid present. The colour does not develop, however, for two days, and the aqueous solution is acid to litmus as a result of hydrolysis. In a solution of pure uranyl nitrate crystals with enough free nitric acid to start reaction with the zinc, it is possible to detect 0·88 mg. of uranium per cc. of solution. By concentration of the solution a more vivid colour is obtained. Gold, platinum, thorium, lead, tungsten, titanium, chromium, mercury, and copper do not interfere with the test. Iron and vanadium interfere only when present in large quantities. In the latter case the spent liquid is removed as soon as action has ceased, and the zinc and the deposit are treated with enough nitric acid to start reaction. The deposit dissolves, but reappears when the acid is again exhausted, and vanadium and iron remain in solution. The test is not applicable in the presence of sulphuric or hydrochloric acids, when a black deposit is obtained. The yellow deposit appears only in an oxidizing solution of nitric acid, for uranyl salts are readily reduced to uranous salts by nascent hydrogen. This should, however, serve as a preliminary test to indicate the presence of uranium at the beginning of an analysis, rather than as part of a systematic scheme of qualitative separation. The deposit in question is presumably $UO_3 2H_2O$. This is the only oxide which corresponds in colour to the deposit obtained.

The Migration of Oil.—In January last we quoted from a paper published in *Economic Geology* for October, 1921, by J. L. Rich on the migration and accumulation of oil, in which he put forward the theory that moving underground water was the cause, rather than the buoyancy of the oil, when the oil moves up the planes of rocks of low dip. In *Economic Geology* for July, 1922, Harold V. Dodd gives a similar theory, with details of corroborative experiments. It is noteworthy that Mr. Rich and Mr. Dodd worked independently without any knowledge of each other's ideas. The experiments made by Mr. Dodd consisted in forcing water or gas or both through various combinations of oil and water sands packed in a glass tube, under which conditions the oil could be made to migrate rapidly up very low dips. We give a summary of his conclusions herewith.

Buoyancy alone is too small a force to cause migration of oil or gas up low or moderate dips. The difference in capillarity between water and oil is not a driving force. Gas pressure alone will not move oil to any considerable distance, either in dry or moistened sands, unless the oil is present in large enough quantities to prevent the gas from blowing through, and then the movement is in mass. The pressure of moving water will cause the migration of oil up any dip, or even down dips, provided the pressure is sufficient to distort the oil globules to the dimensions of the openings between pore spaces. The only resistance to this distortion (assuming viscosity to be negligible) is the tendency of the surface tension of the oil globules to keep them spherical. Migration due to moving water is very much more active when gas bubbles are present. Part of the oil moves as films around the gas bubbles. This process is especially active in moving trapped oil globules. There is very little frictional resistance to the movement of oil through water-sands, because of the lubricating effect of the water. The resistance to movement is chiefly capillary. Surface tension at the water-oil interface, and adsorption of oil at the water-gas interface, are factors of far more importance than has been supposed heretofore. When water conditions are static, gas will not aid the migration of oil along low or moderate dips to any appreciable extent.

SHORT NOTICES

Mine Ventilation. — In the *Engineering and Mining Journal-Press* for July 8, C. N. Schuette describes the means taken for ventilation at a silver mine near Rico, Colorado, in which incoming water introduces carbonic acid and sulphuretted hydrogen to the atmosphere.

Present Values. — In *Mining and Metallurgy* for July, Edwin S. Berry discusses present value in its relation to ore reserves, plant capacity, and grade of ore.

The Chain Pump.—*Engineering* for June 30 gives particulars of the Aquatole endless-chain

pump, in which water is raised by a rapidly moving endless chain. Reference may also be made to a note on this type of pump in the MAGAZINE for May, 1920, in which attention is called to an article in *Engineering* for April 2 of that year.

Diamond - Drilling for Oil. — The *Canadian Mining Journal* for July 7 contains an article by F. A. Edson giving experience in connexion with prospecting for oil with the diamond drill.

Zinc.—In *Mining and Metallurgy* for July, W. R. Ingalls reviews recent developments in the zinc industry.

Zinc Smelting.—In the *Engineering and Mining Journal-Press* for July 1, C. H. Fulton describes a proposed plant for the electrothermic distillation of zinc ores, designed on the system noted in the MAGAZINE for April, 1917.

Recovery of Precious Metals.—In the *Journal* of the Society of Chemical Industry for July 15, E. Gardner gives methods of recovering precious metals and their salts from waste solutions in various industries, such as photography, glass-silvering, gilding, and electroplating.

Dust and Fume.—The *Journal* of the Society of Chemical Industry for June 30 publishes a paper by Dr. W. E. Gibbs on the industrial treatment of fumes and dusty gases.

Calcium Arsenate. — In *Chemical and Metallurgical Engineering* for June 21, H. W. Ambruster writes on the production of calcium arsenate in America. This chemical is in demand for the purpose of combating insect plague in the cotton districts of the Southern States.

Metallurgy at the Hollinger. — In the *Engineering and Mining Journal-Press* for June 24, P. A. Robbins writes on the development of metallurgical practice at the Hollinger gold mine, Porcupine.

Burma Corporation. — In the *Engineering and Mining Journal-Press* for June 24, Allan B. Calhoun writes on the history and present operations at the Bawdwin lead-zinc-silver mine of the Burma Corporation.

Madagascar Graphite. — The *Bulletin* of the Imperial Institute, No. 1, 1922, just published, contains an article on the graphite industry of Madagascar. The bibliography appended does not contain any reference to the article on the subject by John W. Shelley, which appeared in THE MINING MAGAZINE for June, 1916.

South African Oil-Shales. — In the *South African Mining and Engineering Journal* for July 1, F. W. Girdler-Brown writes on the progress made in the establishment of an oil-shale industry in South Africa.

Coal-Mining in Newfoundland. — The July *Bulletin* of the Canadian Institute of Mining and Metallurgy contains a paper by George Morley recounting the various efforts to mine the Newfoundland coal deposits.

Coal-Mining in Malaya. — The July *Bulletin* of the Canadian Institute of Mining and Metallurgy contains a paper by T. L. McCall on the Batu Arang coalfields, Selangor, Federated Malay States.

Pulverized Coal. — *Engineering* for July 14 contains an illustrated description of the "Atritor" coal-pulverizing machine, invented by C. E. Blyth, of Rugby.

Power for Ireland.—The *Journal* of the Royal Society of Arts for July 14 reports a lecture by George Fletcher on the power resources of Ireland, dealing with coal deposits, peat, and water power.

RECENT PATENTS PUBLISHED

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.*

34,394 of 1920 (155,822). E. C. MORGAN, New York. A mining and loading machine which undercuts the deposit by wheel-tools and then digs the material and loads it into trucks.

34,587 of 1920 (181,036). SULLIVAN MACHINERY Co., Chicago. Coal-mining machine adaptable to either long-wall or room-and-pillar methods.

36,516 of 1920 (163,973). F. C. FRARY and ALUMINIUM CO. OF AMERICA, Pittsburgh. Improvements in the method of producing anhydrous aluminium chloride.

1,392 of 1921 (157,461). W. WEBER & Co., Wiesbaden, Germany. A flushing apparatus for excavating and conveying clay or similar material.

3,681 of 1921 (160,449). F. M. SLATER and INGERSOLL-RAND Co., New York. In hammer rock-drills a means for rotating the drill steel independent of the piston.

5,626 of 1921 (181,775). E. E and P. C. DUTT, London. Treating certain bauxites for the extraction of titanium oxide by heating the bauxite under pressure with sulphate of ammonia and thus making soluble sulphates of iron and alumina, the titanium oxide being unaffected.

5,759 of 1921 (181,781). LEADIZING Co., Chicago. Coating iron and steel articles with lead by dipping them in a solution containing lead acetate and acetic acid.

6,889 of 1921 (181,086). F. A. STEART, Glencoe, Natal. Ventilating fans for mines, similar to aeroplane propellers, arranged on one shaft and enclosed in a tube built into the fan drift.

7,893 of 1921 (181,788). A. R. MANGNALL, Chester. Improvements in the inventor's machine for boring through earth without removing any material.

7,898 of 1921 (181,132). A. J. STUBBS, Castellon de la Plana, Spain. Bleaching kaolin and other minerals by the action of hypo-sulphurous acid, made by contact of sulphurous acid with pieces of metal, and so making a soluble compound of the staining minerals occurring with the kaolin.

8,529 of 1921 (160,426). A. PACZ, Cleveland, Ohio. Improvements in the inventor's method of producing alloys of aluminium and silicon.

9,740 of 1921 (182,222). M. B. WILD, Birmingham. Improved brake for hoisting and hauling engines.

10,205 of 1921 (180,837). R. D. PIKE, San Francisco. Method of reducing the lime content of calcined magnesite.

11,494 of 1921 (181,194). V. L. WILLIAMS, Newport, Monmouth. A rock-drill in which the reciprocating motion is obtained by a rotating cam and spring.

11,563 of 1921 (178,720). E. STAHLBERG, Berlin. An improved rock-drill bit.

11,717 of 1921 (164,719). DEUTSCHE GOLD UND SILBER SCHEIDE ANSTALT VORMALS RÖSSLER, Frankfurt am Main. Method of removing sodium chloride from sodium cyanide which has been formed by the reaction of sodium chloride on calcium cyanamide.

12,233 of 1921 (163,263). AKTIEBOLAGET FERROLEGERINGAR, Stockholm. Improvements in the inventor's method of producing ferro-chrome low in carbon and silicon.

13,328 of 1921 (178,347). J. E. GREENAWALT, New York. Improved grate for sintering pan.

17,574 of 1921 (181,984). BERTRAM HUNT, London. Method for separating finely divided elemental sulphur from water, without at the same time removing gangue material.

17,631 of 1921 (179,458). G. H. T. and P. RAYNER, Sheffield. Improvements in valve-gear of rock-drills.

25,247 of 1921 (181,284). METALLBANK UND METALLURGISCHE GESELLSCHAFT, Frankfurt-am-Main. Insulators for electrodes used in electrostatic dust and fume precipitators.

28,241 of 1921 (170,601). SIEMENS SCHUCKERT, Berlin. Improvements in methods for electrostatic precipitation of dust from gases.

31,740 of 1921 (180,968). JACKSON & CO., Valparaiso. Improvements in the inventors' method of extracting silver from complex ores, first oxidizing by means of nitrate of soda, and then subjecting to a chloridizing roast.

35,150 of 1921 (177,123). J. L. MITCHELL, New York. Improved apparatus for use in the manufacture of lithopone, the pigment consisting of barium sulphate and zinc sulphide, the object being to obtain a better calcination of the precipitated product and to prevent the undue formation of zinc oxide.

4,010 of 1922 (175,289). C. BÖHM, Ostrau, Czecho-Slovakia. Improvements in jigging conveyors.

4,744 of 1922 (175,648). GEBRÜDER EICKHOFF, Bochum, Germany.

7,291 of 1922 (182,068). F. WELLS, London. Attaching blasting cartridge to fuse by means of a tubular rubber sleeve.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

Geology of Corocoro Copper District, Bolivia. By J. L. SINGEWALD and E. W. BERRY. Published by Johns Hopkins University Press, Baltimore, U.S.A.

Geology of Huancavelica Mercury District, Peru. By J. L. SINGEWALD and E. W. BERRY. Published by Johns Hopkins University Press, Baltimore, U.S.A.

Quicksilver. Pamphlet, 40 pages. Price 1s. net. Published by the Imperial Mineral Resources Bureau.

Ontario Department of Mines, Part IV of the 30th Annual Report. This section of the Report for 1921 deals with the Schreiber-Duck Lake Area, Thunder Bay District, and the Goudreau Gold Area.

The Madill-Denison Oil and Gas Area, Oklahoma and Texas. By O. B. HOPKINS, SIDNEY POWERS, and H. M. ROBINSON. Bulletin 738A of the United States Geological Survey.

Iron Ore: Summary of Information as to the Present and Prospective Iron-Ore Supplies of the World. Published by the Imperial Mineral Resources Bureau. Part 1, United Kingdom, price 6s.; Part 2, British Africa, price 3s.; Part 3, British America, price 3s. 6d.; Part 4, British Asia, price 2s. 6d.; Part 5, Australia and New Zealand, price 4s.; Part 6, Foreign America, price 4s. A comprehensive review of these and other volumes will appear in an early issue.

COMPANY REPORTS

Minerals Separation. — This company was formed in 1903 by Messrs. Ballot, Webster, and Hay to work concentration processes, of which the Sulman-Picard-Ballot process for flotation with small quantities of oil has proved the most important. The company now owns a large number of patents for flotation and other concentration and metallurgical processes. The report for 1921 shows an excess of expenditure over revenue to the extent of £24,000. The result is largely accounted for by the continued depression in the base-metal industry, entailing a large decrease in the output of metal by licensees and consequent loss of royalties. In the coal trade also, last year was a period of poor trade, which, aggravated by labour strikes, has hindered the rapid erection of plants to take advantage of the company's coal-saving methods. It is evident, however, from the many inquiries which are being received for plants for use at home and abroad, that this position is now slowly improving. The base-metal industry in Australia was not in so depressed a condition during the year under review as it was in the previous year, and the cessation of the strike at Broken Hill and consequent resumption of work to some extent at the Broken Hill mines, enabled the subsidiary Australian company to pay dividends on a small scale during the year. The Braden Copper Company in South America during the year treated 676,795 tons of ore; this tonnage compares with 2,141,594 tons of ore treated in 1920. The activities of the subsidiary Spanish Coal Company during the year under review have been greatly hindered by labour strikes and general industrial unrest in that country. Business in Spain, however, is making steady progress in spite of these difficulties. Research work in connexion with the company's coal processes has been continued with the result that further improvements have been evolved which have greatly contributed to the success obtained in the large scale trials of the new briquetting system which have just been completed. It took a much longer time to commence these trials than was expected, but the commercial utility of the process has been amply demonstrated thereby, and the advantages claimed in the report last year for the new briquetting system have been proved. In view of the success achieved in these trials, upon which the Powell Duffryn Steam Coal Company and this company have been jointly engaged, the long term agreement between the two companies has been definitely signed. Research work is also responsible for the discovery of a method which will solve the problem of reducing the moisture contained in coal to so low a percentage that it is suitable for dry coking practice. The plant for carrying out experiments on a commercial scale in Chile for demonstrating the advantages of the company's methods for improving the recovery of nitrate of soda has been erected, but the work so far accomplished has not enabled any definite conclusion to be formed. The company's expert is now returning from Chile to discuss various points which have arisen. Thorough investigation is still being carried on with regard to the treatment of gold ores by flotation, both in London and in South Africa. A new plant to treat 250 tons of gold ore per day is now in course of being installed in the Transvaal. As regards the new ore reduction process, referred to a year ago, treatment by this

process of many classes of ore on a semi-commerical scale has proved successful. The adoption of this new process will render profitable ores in various parts of the world at present untreatable, and the company has obtained options over considerable deposits of this class of ore.

Transvaal Gold Mining Estates. — This company was formed by the late Nicol Brown in 1882 to acquire a group of gold-mining properties in the Lydenburg district of the Transvaal. In 1895 it was amalgamated with the Lydenburg Mining Estates, since when it has been in the control of the Central Mining and Investment Corporation group. The report for the year ended March 31 last shows that 146,100 tons of ore was treated at the Central mines, yielding 19,771 oz. of gold by amalgamation and 22,230 oz. by cyanide, the gold including premium realizing £211,416, against mining costs of £199,377. At the Elandsdrift mine 18,875 tons of ore gave 5,702 oz. by amalgamation, and 5,469 oz. by cyanide, the gold including premium selling for £56,339, against costs of £37,843. At Valhoek mine, 21,655 tons of ore gave 3,373 oz. by amalgamation, and 3,914 oz. by cyanide, the gold selling for £36,997, against costs of £42,792. The total income was £304,753, and the total mining costs £280,013, to which must be added £7,489, representing the office and administration expenses. The working profit was £17,250, to which was added £11,165, incomes derived from other sources. No dividend was distributed. As compared with the previous year, the amount of ore milled was slightly less, the premium on gold less by 3s. 1d. per ton milled, the costs 1s. 9d. per ton higher, and the yield per ton 1s. 4d. less at par. The increase in costs was largely due to the more vigorous policy of prospecting and development. The comparatively low grade of the ore at the Central group is causing some anxiety. The ore reserves are calculated as follows : Central, 518,614 tons, averaging 6·98 dwt.; Elandsdrift, 76,906 tons, averaging 14·45 dwt. ; Vaalhoek, 78,235 tons, averaging 8·3 dwt.

Abbontiakoon.—This company was formed in 1909 to consolidate gold-mining properties at Tarkwa, West Africa. Edmund Davies is chairman, and the mining staff of the Consolidated Gold Fields are consulting engineers. The issued capital is £636,800, and only small dividends have been paid. The report for 1921 shows that 83,114 tons of ore was sent to the mill, and that 32,999 oz. of gold was won. The sale of the gold brought an income of £173,920, of which £34,103 represented premium. The working cost was £196,727, so that there was a loss on the year's work of £22,806. Development along the lode to the north on several levels has disclosed ore, but efforts to find the lode below the 16th level have not yet been rewarded with success. The reserve is estimated at 447,473 tons, averaging 9·93 dwt. per ton.

Willoughby's Consolidated. — This company's chief business is the development of land in Rhodesia, but it also has mining interests. It is in the control of the British South Africa Co. The report for 1921 shows that the company holds shares in the Eileen Alannah Mining Co., the Connemara Mining Co., and the Birthday Asbestos. At the Eileen Alannah 18,117 tons of ore yielded gold of a value of £19,256. In the early part of the year heavy rains retarded work. The prospects of the mine at the present date have considerably improved, a new slime plant has been installed, and the latest mining developments are of a promising character. At the Connemara 27,424 tons yielded gold of a value of £32,929. The ore reserves at the end of the year were estimated at 45,500 tons. At the Birthday Asbestos mine production was carried on continuously until the end of August, during which time 2,167 tons of fibre was sold. Owing to trade conditions in the asbestos market, it was decided to temporarily suspend production as from September 1, and advantage was taken from this date of re-arranging the milling plant with the object of producing a graded product more suitable for market purposes. This has been completed, and samples of the graded fibre produced have given satisfaction to the trade. The mill was restarted in March last, and the mine is now in a position to supply market requirements. The development work carried out during the year opened up fibre of excellent quality. The company's profits from its mining interests was £11,617, and income from other sources brought the revenue to £31,521. After payment of debenture interest and depreciation, and allowing for taxes, the balance of profit for the year was £163.

Rhodesia Broken Hill. — This company works a lead-zinc deposit in Northern Rhodesia, which was described in detail in an illustrated article in our issue of October, 1919. The report for the year 1921 shows that 43,285 tons of oxidized ore was raised and treated in the blast-furnaces, where 18,122 tons of lead was produced. During the first six months of 1922, the production of lead was 11,134 tons. In the course of extracting the lead ore during the year under review, 21,829 tons of oxidized ore, containing more zinc than lead, was extracted and placed on the dump. All the ore came from open-cuts on No. 1 kopje. Investigations have been continued with regard to the treatment of the zinc and vanadium in these deposits. The combating of the water is still a problem, before mining can be undertaken at depth. As recorded last year, the François cementation method was adopted at the two shafts. It is now recorded that, at the end of 1921, the main shaft was down 190 ft. and No. 2 shaft 119½ ft. The accounts show an income of £390,152 from lead, and £7,995 from vanadium ore. The net profit was £32,860, and £35,000 has been distributed among shareholders, the dividend being at the rate of 10%.

British Broken Hill.—The report of this company for the year 1921 shows that mining and milling were conducted from January 1 to 29 (at which date the fire occurred at the Port Pirie smelters), and from December 12 to 31. Operations have been continued since the latter date without check. During the periods of work there were raised 825 tons of carbonate ore, averaging 24% lead and 5·23 oz. silver, and 20,878 tons of sulphide ore, averaging 13·5% lead, 12·3% zinc, and 7·4 oz. silver. The lead concentrator treated this sulphide ore and produced 3,667 tons of lead concentrate, averaging 60·8% lead, 7·3% zinc, and 26·3 oz. silver; the zinc plant treated 14,790 tons of tailing, averaging 13·3% zinc, 3·2% lead, and 3·2 oz. silver, and produced 3,470 tons of zinc concentrate, averaging 44·7% zinc, 8·8% lead, and 10 oz. silver ; 2,371 tons of slime averaging 13·7% zinc, 5·1% lead, and 4·4 oz. silver was stacked for future treatment. The sulphide ore reserve is estimated at 1,092,226 tons, averaging 13% lead, 11·6% zinc, and 7 oz. silver. The accounts show a loss of £33,880. The company is commencing an action in

Australia with the object of securing a modification of the terms imposed by the contract with the Broken Hill Associated Smelters. The company protested at the time the contract was made in 1917, but had to accept them, as there was no alternative outlet. It is considered that some modification should be made under present conditions. The company is also awaiting the report of the Health Commission appointed by the New South Wales Government to inquire into the health conditions at the Broken Hill mines.

Amalgamated Zinc (De Bavay's).—This company was formed in 1909 to treat zinc tailing by the De Bavay flotation process, particularly the tailing produced by the North and South Broken Hill companies. Subsequently the Minerals Separation process was adopted instead. The company has also acquired a large financial holding in the Electrolytic Zinc Co., of Australasia. The report for the half year ended December 31 last shows that 154,560 tons of material was treated, yielding 43,230 tons of zinc concentrate averaging 45·8% zinc, 8·8% lead, and 13·9 oz. silver per ton, and 254 tons of lead concentrate averaging 50·7% lead, 15·4% zinc, and 83 oz. silver. The working profit was £2,461, and other items of revenue brought the income to £7,332. The sum of £25,000 was distributed among shareholders, at the rate of 1s. per £1 share, the funds coming from the dividends equalization reserve, earned prior to 1913.

Sons of Gwalia.—This company was formed in 1898 to work gold-mining properties at Mount Leonora, West Australia. Bewick, Moreing & Co. are the general managers. Operations were continuous until January 19, 1921, when the surface plant was destroyed by fire. The report now issued covers the year 1921. From this it is seen that the conditions are not yet favourable for rebuilding the mill. The fine-grinding and cyanide plant for treatment of accumulated sand and slime was put into commission in September, 1921. From then to the end of the year 36,715 tons of this material was treated, for a yield of 2,890 oz. of gold. The income thus derived has been sufficient to meet all current expenditure at the mine.

South Kalgurli Consolidated.—This company was formed in 1913 to amalgamate the South Kalgurli and Hainault gold mines at Kalgoorlie, West Australia. The report for the year ended March 31 last shows that 81,368 tons of ore was raised, and sent to the mill, where 35,964 oz. of gold was extracted. The par value of this gold was £139,938, and the premium brought an extra income of £31,871. The net profit was £29,100, and £3,151 was brought forward from the previous year. The dividends amounted to £31,250, the rate being 25%. Owing to the high costs prevailing, it was necessary to mill ore of a grade higher than the average of the reserve. Development on the 1,600 ft. level has given, and continues to give, good results. The reserve is estimated at 176,000 tons, averaging 7·43 dwt.; in addition probable ore stands at 83,000 tons, averaging 5·93 dwt.

Lake View and Star. — This company was formed in 1910 to amalgamate the Lake View Consols and the Hannan's Star companies at Kalgoorlie, after the former had ceased to be a big gold producer. In 1915 the Chaffers gold mine was purchased. James Brothers are the consulting engineers. The report for 1921 shows that 57,370 tons of ore was raised and sent to the mill, where 15,892 oz. of gold was extracted. In addition, 17,017 tons of ore was purchased from tributers. The revenue from bullion and royalties was £110,403, and there was a profit of £5,541. The directors have decided to reorganize the treatment plant at considerable expense, with the object of lowering the costs. Development, though restricted, gave results of importance during the year. The reserve is estimated at 223,297 tons, averaging 26s. 10d. per ton, as compared with 242,442 tons, averaging 26s. 9d. the year before. The reserve is distributed as follows: Lake View, 65,343 tons, averaging 29s.; Hannan's Star, 154,204 tons, averaging 25s. 8d.; Chaffers, 3,750 tons, averaging 35s. 4d.

Oroya Links. — This company was formed in 1896 as the Golden Link Consolidated to work gold properties at Kalgoorlie, and in 1909 the mill of the defunct Oroya-Brownhill mine was acquired. Five years ago the properties were let on tribute. Bewick, Moreing & Co., are the general managers, and J. H. Cordner-James is chairman. The report for 1921 shows that the tributors extracted 10,790 tons, and that 6,023 tons of ore from other sources was purchased. The revenue from bullion and royalties was £90,309, and there was an adverse balance of £2,044 on the year's operations. As already recorded, the company has bought the Kalgurli mill, by means of which it is expected to increase the amount of ore treated, and substantially decrease the costs. In particular it is intended to reopen the Eclipse section where there are very large amounts of low-grade ore.

Cornish Kaolin.—This company was formed in 1912 to develop china-clay deposits on Bodmin Moor. In 1921 Tehidy Minerals, Ltd., the owners of the mineral rights, acquired control, and additional capital was subscribed by other members of the Bewick, Moreing & Co. group, notably Sons of Gwalia. The report now issued covers the year ended March 31 last. During this period operations were centred on development and equipment. Pitting and deep boring were done at Glynn Valley and Burnt Heath. The results of this work, as regards area and depth of deposit and quality of clay, have been uniformly satisfactory. For the present operations are being confined to the Glynn Valley and Merrifield deposit, and the Burnt Heath deposit will be reserved for future requirements. Owing to shortage of labour in war time the removal of surface overburden was in arrears, but during the year this has been overtaken, some 25,000 yards having been shifted at the Glynn Valley property. The overburden is now well clear of the pit edge, and surface drainage has also received attention. At the time the company took over the property there were large accumulations of rubbish, which have now been removed and the pit is in a position to wash a clean sample from any section. The old overburden dump was on clay-bearing ground, and the incline was therefore shifted to deposit this material on barren land. Similar provisions are now being made for the disposal of sand. The pit equipment has been rearranged for greater convenience and economy in working. The old oil-driven pumping sets have been replaced by a more compact and economical electrical set, and the pipe-lines have been rearranged to reduce frictional loss. A high-pressure water service has been installed for operating the monitors, which have already appreciably reduced the cost of clay washing. The former power plant

consisted of three independent oil-engine units which have been replaced by a central plant, consisting of an anthracite producer, twin gas engine, chain-driving a countershaft from which are driven the haulage winches and the electric generator. The electric generator supplies current for the electric pumping set in the pit and also for lighting purposes, while the haulage winches operate on the overburden and sand inclines. The plant is suitably housed, and in its design careful consideration has been given to fuel economy, flexibility of operation, and reduction of costs to a minimum. This section of the equipment is now complete, and has a capacity sufficient to deal not only with present requirements and such extension of operations as are now under consideration, but, by addition to the pumping equipment, with still greater output. A concrete launder has been constructed to convey the clay-wash from the pump delivery main to the sand drags and micas, which constitute the refining section. These latter have been constructed of concrete throughout and are so designed as to permit of the closest regulation of operations and to allow of ready extension for any future requirements. Their present capacity, however, is considered ample for the output contemplated in the next few years. The stream of refined clay passes from the micas into deep settlers, which deliver into the pipe-line connecting to the dry tanks a steady stream of thickened refined clay and return the clear water overflow for re-use. Special care has been taken to prevent any contamination of the clay, and provision has been made to meet any possible demands for a very highly refined product. As far as possible, all operations are automatic and operating costs should be very light. All such duplications of connexions as may be necessary for any future extensions have been provided. This section of the new equipment is now in operation. A number of minor repairs have been made to the No. 1 dry at Bodmin Road, and good progress is being made with the erection of the No. 2 dry. This work should be completed in the course of the next few months, when the present output can be doubled.

Tehidy Minerals.—This company was formed in 1919 to acquire the mineral rights of the Tehidy estate at Camborne with the exception of those of Dolcoath and East Pool. Later in the same year the mineral rights of the Lanhydrock estate were acquired. Full particulars were given in the MAGAZINE for July, 1919, and April, 1920. The report for 1921 shows that the depression of trade and industry has prevented the company from dealing with any of the undeveloped tin and china-clay properties within its areas. The Halviggan china-clay works, purchased from H. D. Pochin & Co., have been put into order, and are now ready to produce high-grade china-clay; development has disclosed large bodies of clay. The Cornish Kaolin Co., in which the company has a large interest, has proved deposits of china-clay at Glynn Valley and at Burnt Heath. Contracts have been made with William Varcoe & Sons, Ltd., of St. Austell, for the sale of the output of the china-clay produced by the company and by the Cornish Kaolin Co.

Kaduna.—This company was formed in 1910 to acquire alluvial tin properties on the western side of the Bauchi Plateau, Nigeria. The report for the year ended October 31, 1921, shows that 170 tons of tin concentrate was won, and that the working profit was £162. It has also been necessary to provide £1,465 for income tax, and £1,270 as note interest, and to write off £1,468 for depreciation of plant and buildings. In August, 1921, the company took financial interest in the London Smelting Co., of Penryn, Cornwall, and has been thereby enabled to obtain a reduction in smelting, landing, and realization charges. The company has been purchasing metallic tin with the proceeds of the sale of concentrate and is holding it for a rise in price. Mining operations were suspended two months ago.

Kaduna Prospectors. — This company was formed in 1913 as a subsidiary of the Kaduna, and owns alluvial tin property in the southern part of the Bauchi Plateau, Nigeria. The report for the year ended October 31, 1921, shows that 116 tons of tin concentrate was won, and that there was a working loss of £1,438. In addition £359 was written off for depreciation, and £1,270 was paid as note interest. With the Kaduna, the company took shares last year in the London Smelting Co., and obtained rebates in costs thereby. Two months ago mining operations were suspended owing to the present unfavourable conditions.

Naraguta Extended Tin Mines. — This company has worked alluvial tin properties in the northern part of the Bauchi plateau, Nigeria, since 1911. During the last year or two the properties have been let to H. V. Smith on contract. The report for 1921 shows that 200 tons of tin concentrate was won, as against 224 tons in 1921, and 276 tons in 1920. The accounts for the year show a loss of £4,609. It is stated that the additional properties mentioned in the report for 1919 have been tested during the year and the existence of tin in satisfactory amounts has been proved.

Briseis Tin and General Mining.—This company has operated alluvial tin properties in the north-east of Tasmania since 1899. The report for 1921 shows that most of the year was devoted to the banking of old tailings, whereby it will be possible to divert the Ringarooma River once more, and thus make available further tracts of tin-bearing ground. It was possible to do a limited amount of sluicing. On Krushka's Flat 165,600 cu. yd. of overburden and tin ground was sluiced, for a yield of 73·6 tons of tin concentrate, and on the Ringarooma property 71,200 cu. yd. gave 30·5 tons, making a total of 104 tons. This was smelted at the company's Launceston plant, and 75 tons of metallic tin extracted. The revenue from the sale of tin was £12,399, and the loss for the year was £14,628. The latest news is that the diversion is practically complete and that sluicing will be commenced at once.

Ipoh Tin Dredging.—This company was formed in 1913 to work alluvial tin properties at Lahat, in the State of Perak, Federated Malay States. A bucket-dredge started operations in 1915, and another dredge is almost ready to be put into commission. The company also acquired land near Taiping, and ordered a third dredge. Owing, however, to financial stringency, the company has not been able to complete the purchase of this dredge, so has sold it and the land to the Kamunting Company. The report for the year ended March 31 last shows that 209 tons of tin concentrate was produced, as compared with 162 tons during the previous year. The yield per yard was 0·78 lb. as against 0·68 lb. The accounts show a loss for the year of £11,910, arising from the low price of tin. Further information is given in Review of Mining.

Kramat Pulai.—This company belongs to the Tronoh group and was formed in 1907 to work alluvial tin property in the Kinta district of Perak, Federated Malay States. Subsequently an alluvial deposit of scheelite was worked. The report for 1921 shows that 344,500 cu. yd. of ground was sluiced for a yield of 263 tons of tin concentrate, comparing with 112 tons the year before. Owing to the lack of demand for tungsten ores, the scheelite deposit was not worked. The company received £18,883 from the Government as compensation for the cancellation of the contract for the purchase of scheelite. The accounts show a profit of £7,184 for the year, arising from the tin operations, and after allowance for taxes and depreciation, the total profit was £22,407, out of which £15,000 has been distributed, being at the rate of 15%.

Mond Nickel.—This company, which owns nickel-copper mines at Sudbury, a smelter at Coniston, Ontario, and a refinery at Swansea, has issued its report for the two years ended April 30. The profits were £610,383, out of which £220,000 was distributed as dividends on the preference and ordinary shares for the year ended April 30, 1921, and £242,500 for the year April 30, 1922. For the former year the ordinary rate was 5%, and for the latter 7½%. Income tax takes £110,000. The directors state that trade conditions in the metal industry during the period under review have continued to be unfavourable, with the result that the operations of the company, both in Canada and in Great Britain, had to be conducted on a reduced scale. Among the company's investments is included the amount paid for the shares of Henry Wiggin & Co., Ltd., Birmingham, which were acquired in 1920. No dividends have yet been received from that investment, but the directors are satisfied that no alteration is necessary in the value at which the shares stand in the books, being of opinion that the setback in that business is due to the present depression in the metal industry. The world stocks of metallic nickel which had accumulated owing to the war have been mostly absorbed. The company has, however, on hand considerable stocks of intermediate products which were manufactured in Canada at high cost for war purposes. These have been written down substantially in the accounts now presented.

Poderosa.—This company was formed in 1908 to work copper properties in the Collahuasi district, Chile. The ore is of high grade, but climatic conditions are difficult, and the company has suffered from the effects of the war and from the present low price of copper. Dividends were paid for 1909, 1916, 1917, and 1920. The report for the year 1921 shows that operations were devoted chiefly to development, and production was confined to the ore obtained in the course of this work. The amount produced was 2,021 tons, averaging 27¾% copper. In addition, 110 tons of concentrate, averaging 26%, was obtained from 1,342 tons of ore, averaging 4·2%, by treatment in the old concentrator. This old plant is not now in commission, as a Minerals Separation plant with a capacity of 50 to 75 tons per day has been erected, which is now running experimentally. Besides the shipping ore, 5,172 tons of ore, averaging 6%, was added to the dumps awaiting concentration. The ore reserve at the Poderosa mine is estimated at 6,530 tons, averaging 30%, and 6,680 tons, averaging 5%; also 7,730 tons, and 2,775 tons of similar grade respectively are reported as probable ore. At the surface the old dumps contain 144,000 tons, averaging 3¼%, in addition to the ore already mentioned as having been extracted during 1921. During the year 2,942 tons of ore was shipped to the smelters, averaging 25% copper and 12·6 oz. silver per ton, and realizing £17,231. The loss on the year's work was £33,219, as compared with a profit of £18,349 the year before.

Libiola Copper.—This company has worked a copper mine in the north of Italy since 1888. The report for 1921 shows that the production of copper ore was 4,080 tons, and of pyrites 5,405 tons, comparing with 2,297 tons and 6,309 tons the year before. The reserve on December 31 was estimated at 6,045 tons of copper ore and 33,910 tons of pyrites. The market for pyrites containing copper has been maintained, and the production of this class of ore was increased. The stock of rich ore was mixed with the pyrites low in copper and sold satisfactorily. The accounts show a profit of £2,320. Italian taxes and the low Italian exchange continue to oppress the company.

Burma Ruby Mines.—This company has worked ruby and sapphire deposits in the neighbourhood of Mogok, Upper Burma, since 1889, but operations have not been very successful since the first three or four years of the company's existence. The report for the year ended February 28 shows that 748,242 loads of ground was washed, as compared with 771,406 loads the year before. The stones extracted were valued at £49,372, as compared with £43,010. Most of the work was done at the Kathé mine. The new mine at Kyaungdwin is now beginning to produce. The sale of rubies amounted to £45,372, as compared with £33,507. The royalty received from tributors amounted to £9,040, which was handed to the Indian Government in lieu of rent. The accounts show an adverse balance of £2,639, comparing with an adverse balance of £1,570 the year before. A deposit of hyalite, or colourless opal, has been discovered, and the value of this stone is being investigated.

New Jagersfontein Mining and Exploration.—This company was formed in 1887 to acquire diamond-mining claims in the west part of Orange Free State, and other adjoining properties were subsequently absorbed. Owing to the great war mining and washing were suspended from August, 1914, to January 2, 1916. Mining was resumed in January, 1918, but has since been discontinued owing to the depression in trade. The report now issued covers the year ended March 31 last. During this time no mining was done. At the washing plant, No. 10 gear worked for the first eight months and two units of No. 13 gear worked throughout the time. The ground washed consisted of hopperings, tailings, cylinder lumps, hardibank, floor cleanings, old sortings, and debris. The total treated was 897,258 loads, and 65,956 carats of diamonds were won, the yield being 7·38 carats per 100 loads. The normal rate of treatment since the war has been about 2,000,000 loads per year, but in the years 1911 to 1914, the yearly totals averaged over 4,000,000 loads. The diamond account showed credits of £134,325, and a net profit of £11,217. During the year a dam was constructed between Nos. 8 and 10 tailing dumps. This dam will hold over 75 million gallons of water and when equipped with pumping plant will supply the boilers and the pulsator grease tables with water, thus reducing the present charges for pumping. A new unit at No. 13 gear is in course of construction.

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EDITORIAL

THE future of the Camborne School of Mines has caused considerable anxiety recently, particularly in Cornwall. Owing to the cut in Government educational allowances, and incidentally also to the local depression in mining, the funds at the disposal of the School are not sufficient to provide for the adequate payment of a principal and a lecturer on mining. To meet the crisis Mr. R. Arthur Thomas has consented to assume these duties. All mining men will thank Mr. Thomas for his public-spirited action, which will assuredly go far towards saving the School.

LIKE most technical societies, the Canadian Institute of Mining and Metallurgy finds the printer's bill a serious drain on its financial resources, and the council states that it has no option but to propose that members shall henceforth pay a subscription for the monthly *Bulletin* in addition to their present subscription for membership, if the publication of this organ is to be continued. We should be sorry if this bright and informative paper were discontinued, and therefore hope that members will be ready to bear the additional burden.

SEARCH for Spanish treasure off the coast of Scotland is revived from time to time. In particular the Almirante de Florencia, one of the ships of the Armada, sunk off Tobermory, on the island of Mull, Argyllshire, is an attractive objective, for old records show that she carried gold, silver, and jewels of considerable value. Nowadays investigations require not only the services of divers, but the provision of suction pumps to remove the accumulated gravel and silt. Another campaign has been started this summer, and on a thoroughly practical scale, so that hopes run high for a discovery of the bullion and precious stones.

ONE of the most important publications in the realm of mining and metallurgy that have been published recently is the report on the iron-ore resources of the world prepared by the Imperial Mineral Resources Bureau. In this issue Professor Henry Louis writes an article on this report, and to his article is appended a brief résumé of the section of the report dealing with the resources of Great Britain. In future issues we intend to continue the résumé and to give outlines of the resources in the Overseas Dominions and in other parts of the world. There is one feature of the Bureau's report which gives it an advantage over the reports on the iron and coal resources of the world prepared by the International Geological Congress; that is to say, it has been prepared on a systematic plan, and has been well revised and edited. The other reports named were merely collections of individual papers, some giving only brief outlines while others entered into unnecessary details; moreover, the separate résumés were not particularly helpful, being too often nothing but abbreviated duplications of the information given in the main papers.

EFFORTS to leach copper and zinc ores by means of sulphurous acid have often been made, but so far without success. Elsewhere in this issue is printed a paper by Messrs. Charles E. van Barneveld and Edmund S. Leaver, recounting experiments in this direction in the south-west copper region of the United States. Their process differs from those of previous investigators in that they convert their sulphurous acid into sulphuric acid in the leaching vessel and so obtain an improved action. With big deposits and rich companies it is probable that sulphuric acid will still hold the field, but Messrs. Barneveld and Leaver's plant will prove attractive to operators who have comparatively small deposits, where expenditure on a sulphuric acid plant would not be warranted. Such operators will read the paper with considerable interest.

MINING engineers and metallurgists will be glad to know that there is a chance of some small abatement of the intolerable financial burden involved in securing patents. Representatives of various constituents of the British Empire have agreed to a scheme for unifying procedure in the United Kingdom, the Dominions, and the colonies and protectorates. Two proposals have been placed before the various Governments for consideration and acceptance. It is not necessary here to go into the technicalities of the report on the subject. Suffice it to say that one examination will be generally sufficient, in a central patent office in London, and that the total fees and agency expenses will be greatly reduced. The average man does not realize the enormous expense to which an inventor is put if he desires to secure protection even within the British Empire. The cost is indeed usually far beyond his personal resources, and, of course,

if he secures financial help, too often it is the moneyed man that obtains the eventual benefit rather than the inventor himself. The unification of patent procedure throughout the Empire does not remove all the present drawbacks. The inventor will still have to deal with the other countries of the world, where, in many cases, expense is not the only factor, for in many countries there is a bias in favour of their own nationals as against the interests of the outside applicant.

British Lead and Zinc Mining

A number of Memoirs relating to lead and zinc deposits in Great Britain, prepared by the Geological Survey, have been published during the past few months, and quotations from some of them have already been made in our pages. In the current issue we give excerpts from Mr. T. Eastwood's report on the Cumberland lead and zinc mines. The lead deposits in this part of England have been worked for many centuries, but probably were never so profitable as the copper deposits were during the Elizabethan era. Of recent years, Mr. Anthony Wilson has done much to revive interest in this industry, and he is at present its most active champion. He has also been pertinacious in his attempts to establish a satisfactory business in the extraction of blende, which has become an increasingly large constituent of the ore-bodies with depth. As our readers are aware, lead and zinc mining in this country has had many ups and downs recently, and at the beginning of the current year there was virtually no work being done. Since then conditions as regards lead have improved, owing to the better price of the metal, and operations have been generally resumed ; but zinc is still under a cloud. It is noteworthy that there is a keen demand for lead concentrates from the Continent, and very low returning charges have been offered. In consequence the home smelters have had to reduce their charges, and are now ready to accept contracts at about £4 10s. per ton returning charge delivered at the works. With these changed conditions it is appropriate to draw attention to the chief activities at the lead and zinc mines in the north of England.

As already mentioned, the chief lead mines have resumed operations ; Wanlockhead, Lead Hills, and Weardale are producing normal quantities. The Weardale Company is engaged on the erection of a three-mile ropeway, and is constructing a siding on the Wearhead branch of the North-Eastern Railway. This ropeway will have a capacity of 12 tons per hour, and will handle galena, fluor-spar, and tailings at a cost much lower than the five-mile private railway to Park Head. The demand for fluor-spar is active, and a large shipping business is now being done from this valley. The Allendale mines are at work on galena, and at this mine, while the quantities are not large, the grade of ore is very rich, and the owners are now considering the installation of a complete slime plant. The Greenside mine was nearly abandoned recently, but some better-grade ore was opened out in the bottom level, and an attempt is now being made to reconstruct the company with a reduced capital. The lessors have become more reasonable, as they realized that their source of income was disappearing, and the terms of royalty now arranged are fairly low. The owners of Threlkeld mines have started operations, and about 36 men are now employed. The mine is looking well for lead, and blende is only a secondary product. A slime plant is being erected. If the market holds good, it is proposed to put in an electric locomotive. The workings are a mile from daylight, and transport by ponies is slow and and expensive. Lord Lonsdale, the lessor, has remitted all royalties until the end of 1922, an example that might be followed in other cases. The only other lead producer in Great Britain is Mill Close, in Derbyshire, the Welsh mines being idle. Other activities at lead mines to be noted are the sinking of a trial shaft at Brundholme, near Keswick, and some exploratory work at Tyndrum, in Scotland. We hear also that certain London interests are contemplating operations in Derbyshire.

The production of blende is confined to Wanlockhead and Threlkeld, and the mines depending on zinc alone are closed down. The Nenthead mines have been definitely closed ; the staff have returned to Belgium, and the plant is being sold. The Thornthwaite mine, which was run by Mr. Wilson, has been closed owing to the zinc preponderating. The price obtainable for good-grade blende concentrates is very low, and for a second-grade blende, one mine has sold its stock of 100 tons at £3 delivered at Antwerp, equal to 20s. at the mine. The home smelters have made an offer of 80s. delivered at works for blende assaying 50% Zn, or say £3 at the mine ; and this with

spelter at over £30 per ton. The Continental demand, however, is keen, and high prices would be obtained abroad but for the sales of Australian zinc concentrates by the Government. One of the producing mines sold 60 tons the other day to a Continental buyer at £5 10s. delivered at Newcastle, or £4 14s. at the mine. But no British mine can produce blende concentrate at anything like £4 10s. per ton. The outlook for zinc mining in Great Britain is hopeless as long as the supplies of Australian concentrate are being realized by the British Government at knock-out prices.

Temperature at Depth

The report by Mr. Ivon Graham to the Institution of Mining Engineers on temperatures at depth in the coal measures of Great Britain is an important contribution to a subject which is nowadays necessarily receiving increased attention on the part of mining men. It will be remembered that some years ago the Institution organized a research committee, in association with the Department of Scientific and Industrial Research, to deal with questions relating to the control of atmospheric conditions in hot and deep mines. Three reports by this committee have already been published. One of these, by Mr. J. P. Rees, discussing hygrometric conditions, was quoted at some length in the MAGAZINE for October, 1919, and June and July, 1920. It became obvious from Mr. Rees's paper that, before satisfactory conclusions could be drawn from comparisons of atmospheric conditions below and above ground, some more definite information would have to be obtained as to the temperatures of the strata before they are attacked or even nearly approached by shaft-sinking or driving. Investigations in this direction have not hitherto been done with any great degree of accuracy, and the results obtained by the British Association's committees, the Coal Resources Commissions, and by individual geologists were not much more than hasty generalizations. Mr. Graham's work has been more elaborate and systematic, and it more nearly meets the requirements of the modern mining engineer.

Mr. Graham begins his report by describing the method employed for ascertaining rock temperatures, and the many unexpected difficulties encountered. It was found best to bore holes 30 ft. long and 2 in. diameter, and to register the temperature by means of water enclosed in an instrument devised by Dr. J. S. Haldane and called a "calorometer." This instrument consists of a short glass tube holding the water, fitting within a similar metal tube, the space between the glass and metal tubes being filled with some badly-conducting substance such as felt. The tubes are open at one end, and are covered by a cap screwed on the metal tube, a rubber pad on the inside of the cap serving to close the glass tube. The apparatus is pushed along the hole, and is kept out of contact with the air by means of an expansible rubber plug. It remains in place for twenty hours or so, and is then withdrawn as rapidly as possible, the cap unscrewed, and the temperature of the water taken. The necessity for having a non-conductor around the glass tube arises from the fact that there is often delay in withdrawing the instrument owing to difficulties with the expanding plugs or to collapses of the sides of the hole. At one time it was hoped that temperatures could be ascertained by the electric couple, but these instruments are costly and their frequent loss would make the investigations far too expensive.

The general results obtained by Mr. Graham over an extensive series of experiments in various parts of Great Britain confirmed the fact already accepted that there are wide regional variations of temperature throughout the earth's crust, that the geothermic gradient differs considerably from place to place, and that at any one place there may be substantial variation in the gradient at different depths. The cause of these regional differences has not yet been proved by demonstration, but clearly they may be due to varying conductivities of the strata, the inclination of the beds, volcanic influences, or movements of underground waters. The relation of the original temperature of the untouched rock to that of the exposed rock and the temperature in the workings also presents a problem of some difficulty, especially when the rock on which the experiments are made is coal. In this case the weathering of pyrites in the coal will cause an increase of temperature, while the formation of gas due to the evaporation of liquid hydrocarbons existing in a state of adsorption will give rise to a cooling effect.

As regards the geothermal gradient in British coal mines, Mr. Graham's figures usually show a slower rate of increase than that hitherto accepted, namely, 1° F in 60 ft., and even slower than the 1905 Commission's

figure of 1° in 64 ft. His highest rate is 1° in 56 ft., but most of the figures show over 1° in 60 ft. In fact there are numerous cases of over 1° in 80° and 1° in 90°, and in one colliery 1° in 106° was recorded. Mr. Graham and Dr. Haldane, however, do not consider these figures final, and they desire more light on the results of evaporation of the adsorbed hydrocarbons. The trouble has always been to prevent this evaporation, but the presence of cracks in the walls of the bore-hole is a serious obstacle. As long as the evaporation is an unknown quantity, it is possible that the temperatures recorded may be too low.

There is another question that has to be settled in connexion with the investigations of mine temperatures. We refer to the estimation of the average temperature of the air entering the mine. It is necessary in discussing ventilation and cooling to know the average temperature of the incoming air as well as that of the air at the bottom of the mine and of the rock itself. At the present time there is no accurate system of recording this surface air temperature. Both Dr. Haldane and Mr. Graham are aware of the necessity for investigations along this line, and the matter is already under consideration. This phase of the question will no doubt form the subject of a subsequent report.

Wegener's Theory

The average mining man finds it difficult to keep in touch nowadays with German thought and literature, and no doubt many new theories and advances in practice emanating from Germany are missed by English and American readers. They will therefore thank Dr. R. H. Rastall, the editor of the *Geological Magazine*, for publishing in the August issue an article by Mr. Philip Lake on Wegener's theory of the displacement or migration of continents. This theory has not received much attention in English-speaking countries, and even a new book such as Hobbs's *Earth Evolution*, just published by Macmillan, contains no mention of it. The theory has no particular bearing on economic geology, but it is attractive to the palæontologists and to the students of glaciation who are nonplussed by the existence of the remains of tropical vegetation near the poles and of glaciation near the equator. Like most theories relating to the ancient history of the earth, Wegener's is a mere surmise, supported by no direct evidence. He follows Suess in holding that the earth is composed of concentric shells, the outer being predominantly acid and the inner basic, these shells surrounding an internal mass of greater density. He proceeds to argue that the outer shell does not cover the earth completely, and that it now exists as independent patches, which float movably on the basic shell below. Here his views may be correlated to some degree with the theory of isostasy, but his ideas provide for a very much greater movement of the surface of the earth than does that theory. It is not quite clear what forces bring about the lateral movements of land surfaces suggested by him, but apparently the revolution of the earth on its axis is an effective one, and he may have had in view also the theory that the Pacific depression was the result of the ejaculation of matter now forming the moon. He appears to have started with the impression which children receive when studying the map of the world, that is to say, that the eastern bulge of South America would fit nicely into the west coast of Africa if it were pushed across the Atlantic. From this he proceeds to argue that Africa and South America were connected with the Antarctic continent, to which he also joins Australia. He also assumes that the folding in the Himalayas occurred about the same time, and consequently he considers that originally India and Madagascar were wedged between Australia and Africa. In the northern hemisphere he suggests that Greenland, eastern Canada, and north-west Europe were continuous, but this part of the world does not give him such satisfaction as the southern hemisphere. His reconstruction of the surface of the earth before these movements would show the conditions at the end of the Carboniferous period after the Hercynian folding. On this supposition many points connected with the palæontological and glacial history of the earth may be explained as far as the southern hemisphere is concerned. Wegener also introduces arguments in favour of his theory depending on the continuity of ancient gneisses in South America and Africa. These at first sight appear attractive, but further examination reveals discrepancies which rather tend to nullify them. It is not necessary to go further into details of the theory in these columns, for the matter is critically and concisely handled by Mr. Lake, and we content ourselves with again recommending readers to study the article in question.

REVIEW OF MINING

Introduction.—The holidays have interfered with any general return to activity, but the position is viewed with some degree of hopefulness. The protracted difficulties with regard to reparations and inter-ally debts, and the consequent exchange troubles, continue to block any adequate revival of business. In the United States the coal miners are mostly back at work and the engineering trades are improving, but the attempts of labour to capture the railroads by forcing them into Government control again is causing uneasiness. In the metal market an increase in the consumption of copper is expected without much advance in price. As regards lead, the price is high, and supplies are low, and this position is likely to continue. Thus many producers are trying to increase their output, and some mines now closed are contemplating reopening.

Transvaal.—Gold mining conditions continue to improve steadily. The output on the Rand is increasing, and substantial reductions are being made in the costs.

Further information to hand confirms the announcement made last month that developments at West Springs have shown substantial improvements lately. It will be remembered that the north shaft at West Springs is connected with the workings in the adjoining Springs mine, and that haulages in north and north-eastern directions are being driven from this shaft. The results in the workings connecting Springs with West Springs shaft were disappointing, but those in the haulages north and north-east are distinctly good. For instance, No. 1 north-east haulage has been in ore for 1,024 ft., the ore averaging 10·7 dwt. over 44 in. for this distance, the last 315 ft. averaging as much as 10 dwt. over 74 in. No. 2 north-east haulage is also in payable ore, the last 275 ft. averaging 7·5 dwt. over 47 in., and the last 210 ft. in the north haulage was in ore averaging 8 dwt. over 36 in. These results give rise to the belief that the northern part of the West Springs property will be proved to contain broad ore-shoots such as are found in the Brakpan and New State Areas to the north.

At the meeting of the H. E. Proprietary Company, the chairman, Mr. F. H. Hamilton, spoke hopefully of the prospects of mining in South Africa, and gave a more encouraging view of the chances of finding capital for new ventures there than has been possible for some years. This company has prepared a plan for the development of the Klippoortje property in the Heidelberg district, in association with the Rhodesia Exploration Co., which controls the adjoining Marais-drift property, and is only awaiting the appropriate financial opportunity to commence operations. In the meantime, the company is more actively interested in Canadian mining and in oil operations.

Many rumours of new gold discoveries in the Transvaal have been prevalent lately. First came stories from Keetmanshoop, and later there have been more or less circumstantial accounts of discoveries in the Rustenburg-Marico district north-west of Pretoria, where gold-bearing conglomerate is reported at points along the Crocodile River valley. As this river crosses Lydenburg and Black Reef formations, there is no reason why gold should not be found, but geologists and mining men are not inclined to believe that it exists in great quantities there, and are awaiting the results of systematic sampling before accepting the reports.

The *South African Mining Review* for July calls attention to the fact that it is just thirty years since the monthly returns of the Transvaal gold mines exceeded 100,000 oz., the figures for June, 1892, having been 103,252 oz. Those returns were in bullion ounces, not fine ounces, but that does not detract from the interest of the reminiscence. This gold was extracted by 63 companies from 158,351 tons of ore, and just over 2,000 stamps were employed. The cyanide process had at that time been adopted by only 15 companies, and of the total output 84,175 oz. was extracted by amalgamation and 19,077 oz. from tailings and concentrates. The mine to treat the largest amount of ore was the Langlaagte Estate, but the Robinson had the largest yield of gold, the return being 8,445 oz., equal to 19½ dwt. per ton. For the purpose of comparison, it may be mentioned that the total output for June, 1922, was 675,697 fine oz., and that 109,917 oz. was extracted from two mines alone, namely, Government Areas and New Modderfontein.

Rhodesia.—The output of gold during July was reported at 54,191 oz., as compared with 55,614 oz. for June and 51,564 oz. for July of last year. Other outputs in Southern Rhodesia reported were :—Silver, 12,927 oz.; coal, 49,973 tons ; chrome ore, 16,803 tons ;

copper, 263 tons; asbestos, 1,443 tons; arsenic, 15 tons; mica, 4 tons; diamonds, 27 carats.

It is announced that the referendum on the question as to whether Southern Rhodesia shall choose self-government or incorporation in the Union of South Africa will be taken on October 10, and the result will be known about a week later.

The Cam and Motor Company reports the ore reserve on June 30 at 680,000 tons averaging 39s. 10d. per ton, as compared with 600,000 tons averaging 38s. 3d. a year previously. In the meantime 168,700 tons was extracted for treatment at the mill.

The Sabiwa gold mine is to be reopened by the London and Rhodesian Mining and Land Co. Before this company acquired the property 150,000 tons of ore averaging 44s. per ton had been proved, and a 40-stamp mill had been erected. The plant is now being reconditioned, and part of it will be started before long.

Congo State.—It is announced that the efforts of Mr. Robert Williams, as chairman of Tanganyika Concessions, to secure a loan through the Trade Facilities Act for the completion of the Benguella Railway between Katanga and the port on the south Atlantic have failed, presumably because the Union of South Africa objected to any scheme which might interfere with the prosperity of the Rhodesia Railways for which it is making a bid. We understand that Mr. Williams is now negotiating with financiers in America for £3,000,000 for this purpose. Obviously it is a pity that the money cannot be raised in this country.

Tanganyika Territory.—Attention to "German East" as a gold producer has been drawn lately by the results obtained by two prospectors on a lode in the Mwanza district. The Government Inspector reports that at a small trial hand-crushing he obtained 3½ oz. to the ton on one of the workings. It will be remembered that the Germans made many attempts to establish a gold-mining industry in this district, but were not able to bring their costs down to an economic level. It is stated that representatives of the Central Mining-Rand Mines group have visited the territory recently, and their report is awaited with interest.

Uganda—A company called the Lado Enclave Syndicate has been formed in London to enable Sir Alfred Sharpe to continue exploration for gold in the Western Nile district of Uganda. As recorded in an article in the MAGAZINE for December, January, and February last, this district is known to contain gold, and the prospects are good. There are now three companies operating in this part of Africa, the others being the Nile-Congo Divide Syndicate, which is in the control of Tanganyika Concessions, and the Belgian-American Compagnie "Forminiere."

Nigeria. — Like most Nigerian tin companies, the Rayfield has been hard hit by the low price of tin lately ruling. For two years or more it has been necessary to curtail output and reduce expenses. Under such conditions, losses were made for 1920 and 1921. Moreover, there has been serious depreciation in the holdings of subsidiary or allied companies. The total adverse balance as at December 31 last works out at £89,729. It is proposed to reduce the nominal capital of the company by writing down the 400,007 ordinary shares of £1 each to a similar number of 10s. each; at the same time it has been agreed that the 100,000 participating preference shares of £1 each shall stand untouched as to capital but made non-cumulative as to dividend. This reduction of capital will make it possible to wipe out the adverse balance, and also to substantially reduce the property account. As regards the value of the properties, no prospecting or testing had been done for eight years or so, owing to war conditions at first and financial stringency subsequently. Much of the tested ground is of too low a grade to pay at present. Thus it is deemed desirable that the value of the company's property should be reduced in the manner indicated.

Australia.—A hitch has arisen in the negotiations between the owners of the coal mines and the miners. This matter has been before a special Federal court for some time; on the one hand the owners desire to cut the wages by one-third, and on the other the miners seek redress of many grievances. Owing to the court requiring the wages to be settled first, before the men's grievances are considered, the men have become dissatisfied, and are threatening a general strike throughout Australia.

The directors of the Broken Hill Proprietary, in their report for the year ended May 31, deal at some length with the industrial situation in Australia, and point to the legal disability of employers to manage their own businesses as the main cause of the present depression in the Australian

metal industry. Wages and hours are fixed by arbitrary legal tribunals, and argument before these involves indefinite delays. Compulsory arbitration is strangling industry in the Commonwealth, and is crippling economic progress. The call is for less Government interference and control.

Last month it was mentioned that tin-winning has been suspended for some months at Briseis, Tasmania, pending a re-diversion of the Ringarooma River. It is now announced that this work has been completed, and that the river is flowing satisfactorily through the new channel. Sluicing operations are to be re-commenced forthwith.

Malaya.—A company called the Kelantan Gold Mines, Ltd., has been formed to work gold areas in the State of Kelantan. Tin has been found on the west coast of Johore, and deposits on the foreshore at Tanjong Segenting are to be dredged.

Canada. — The establishment of an adequate iron and steel industry for Ontario, utilizing local ores, has been the subject of discussion between the Minister of Mines and representatives of various commercial interests. The concentration of these ores is the vital problem, and investigations and tests are to be continued. At present the Algoma Steel Corporation is the only company using these ores.

The American coal strike was not confined to the United States, but it also spread to British Columbia and Nova Scotia. In the latter province, many mines were flooded, and serious damage has resulted thereby. The military were called out, and eventually the Government took active steps to bring about a settlement. The latest news is that the miners returned to work on an increased scale of wages.

The English company formed to acquire the Bingo gold property at Herb Lake in The Pas district, Manitoba, is called the Bingo Gold Mines, Ltd. The capital is £500,000, divided into 125,000 participating preference shares and 375,000 ordinary shares, both of £1 each. The purchase price fixed by the vendor, Mr. Joseph Myers, of Winnipeg, is £325,000, which is satisfied as to £75,000 in cash and as to £250,000 in ordinary shares. The whole of the preference shares have been subscribed and paid for in cash in full, and one ordinary share is given to the holder of each two preference shares as bonus by the vendor, who receives 62,500 of these shares as commission from the company for placing the preference shares, in addition to those paid to him as purchase price. As we mentioned in April, the Bingo is a promising prospect, but it does not warrant this high capitalization.

Mexico.—Mining men will regard with great satisfaction the new scheme for the readjustment of the Mexican public debt, which now awaits endorsement by the Mexican Government and the bondholders. That such a scheme has become possible is evidence that economic and political conditions in Mexico are improving. Mexico still has a fine future as a mining country, and its settlement will be welcome.

Chile.—The resumption of imports of Chilean nitrate by Germany is of considerable scientific importance, and indicates that synthetic nitrogen compounds are comparatively expensive. Last year the small amount of 20,000 tons was shipped to Germany, but now the German Government has granted leave for the import of 200,000 tons. How this purchase is to be financed gives rise to many surmises, but probably Germany has pre-war credits in Chile.

Venezuela.—The British Controlled Oilfields, Ltd., reports agreements with companies of the Standard Oil group for the development of some of its properties in the Buchivacoa oilfields in Venezuela. It also reports similar agreements in connexion with lands held in Colombia.

Russia.—Telegraphic despatches announce that Mr. Leslie Urquhart has been successful in negotiating with representatives of the Soviet Government for a return of the various mining properties to the Russo-Asiatic Consolidated. Whether the agreement will be endorsed by the Soviet Government remains to be seen.

Roumania. — The proposal of the Roumanian Government to nationalize the subsoil is not regarded with satisfaction by oil companies operating there, for the question of compensation would be complicated and well nigh impossible of solution. On the other hand, they have no objection to the Government imposing the new terms on land not yet leased. In fact, they rather urge the Government to settle on some systematic method of dealing with these untried lands.

The Consolidated Gold Fields and the National Mining Corporation are interested extensively in Roumanian oil, and they have combined to form two big operating companies. One has been registered as the Amalgamated Oil Lands of Roumania, Ltd.

THE IRON-ORE RESOURCES OF THE BRITISH EMPIRE

By HENRY LOUIS, M.A., D.Sc., A.R.S.M., M.Inst.C.E., etc.
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The enormous importance of iron, and therefore of iron ore, as a factor in modern civilization has long been recognized and the possession of great iron-ore resources is second only to that of great coalfields in determining the industrial supremacy of a nation. It is beyond question that one of the motives that induced Germany to embark upon the recent world war was her greed for iron ore, her desire to seize upon the iron-ore fields of French Lorraine, which had in the course of time proved to be richer and more valuable than those which she had stolen from her neighbour as the result of the 1870 campaign. In view of the immense value of this national asset, it is somewhat strange that it is only within recent years that any effort has been made to estimate the iron-ore resources that the British nation possesses. The first serious attempt was due to the initiative of the Eleventh International Geological Congress, held in Stockholm in 1910. Apparently it was Professor Högbom who first suggested that the amount and distribution of the world's supply of iron ore would form a suitable subject for discussion at a meeting in the land which had for so many centuries held an eminent and a unique position in the iron industry. The Executive Committee of Swedish geologists, to whom the arrangements for the Congress had been entrusted, eagerly accepted the suggestion, and issued requests to all countries to co-operate with them and to supply a report on their own iron-ore resources. The result was the production of the two well-known volumes, entitled *The Iron Ore Resources of the World*, to which the writer of this article had the honour of contributing the report upon the iron resources of Great Britain. Furthermore, most of the other portions of the British Empire, India, Canada, Australia, South Africa, and the other British colonies and dependencies also sent in reports, so that the iron resources of the British Empire were reasonably well represented. The entire report was a most valuable piece of work, though it is not suggested that the data collected have any great value to-day, save as a foundation upon which other and more complete statistics could be built up. As the French proverb has it, it is always the first step that is the most difficult, and the International Geological Congress deserves the utmost credit for having taken it.

Next in order came a publication by the Department of Scientific and Industrial Research, in the form of a pamphlet of 145 pages, entitled "Report on the Resources and Production of Iron Ores and other Principal Metalliferous Ores used in the Iron and Steel Industry of the United Kingdom," issued in 1917. This was prepared by Mr. G. C. Lloyd, secretary of the Iron and Steel Institute, and the writer of the present article was also fortunately enabled to render some assistance in its compilation. Its object was to bring together in a convenient form an account of the chief mineral resources available for the British ironmaster, and dealt with statistics of production rather than with ore reserves. It served its purpose so well that the first edition was soon exhausted, and a second revised edition was issued in the following year. Meanwhile, the problem of our mineral resources was being energetically attacked in another quarter. Our Geological Survey at last awoke to the fact that economic geology is not one of the least important branches of that subject, and Sir Aubrey Strahan, the Director of the Survey, commenced in 1915 the issue of a most valuable series of Special Reports on the Mineral Resources of Great Britain. To quote his own opening remarks in the preface to the first volume of these reports: "The effects of the war, in increasing the demand for certain minerals of economic value, have led to many inquiries as to the resources in Britain of some materials for the supply of which dependence has been placed upon imports." Among these reports there were issued a number of volumes dealing fully and authoritatively with British iron-ore resources. The Geological Surveys in other parts of the Empire, notably in Canada, had also made exhaustive studies of their own iron-ore resources, and thus an immense mass of most valuable information had gradually accumulated.

One of the useful after-effects of the war was to teach the various units of our great

Empire the value of co-operation and mutual interdependence, and one result of this was the foundation of the Imperial Mineral Resources Bureau under the chairmanship of Sir Richard Redmayne. This Bureau has, as every mining man knows, issued from time to time a number of admirable publications setting out in detail the mineral resources of the Empire, together with indications of the similar resources of foreign countries, covering more particularly the production of these during the war period. When it came to iron ore, it was felt that something more complete was required, owing to the pre-eminent importance of the subject. This desire was expressed by the National Federation of Iron and Steel Manufacturers, who gave practical proof of their interest in the inquiry by supporting it financially. It is a curious reflection that a Bureau representing one of the most vitally important industries of our great Empire should be compelled to appeal to an outside body for funds to accomplish effectively the work for which it was called into being. It is not suggested that there is any hardship to British iron and steel manufacturers to be asked to contribute to a work in which they are so profoundly interested, and by which they will benefit more than anyone else, and it is eminently fitting that they should have done so, but the fact does throw a somewhat lurid light upon the small degree of appreciation that the Empire awards to the accumulation of scientific and technical information.

The important fact, however, is that the necessary financial support was forthcoming, and the Bureau formed a special Iron and Steel Committee, upon which the Federation of Iron and Steel Manufacturers was ably represented. This committee has been exceptionally fortunate in having for its chairman Mr. Wallace Thorneycroft, to whose boundless energy and profound knowledge of the subject it is so greatly indebted. The results of a portion of its labours are now before us; the entire subject is divided into eight parts, as follows:—

British Empire

Part I. United Kingdom.
Part II. British Africa.
Part III. British America.
Part IV. British Asia.
Part V. Australia, New Zealand, and British possessions in the Pacific.

Foreign Countries

Part VI. Europe and Africa.
Part VII. America.
Part VIII. Asia and Pacific Possessions.

The first five parts have been published, and form an exhaustive synopsis of all that is known up to date of the iron resources of our Empire. It is not suggested that it is necessarily quite complete; indeed, it cannot be, because vast tracts of that Empire still remain unexplored, as far as their resources of iron ore are concerned, and in others the locally available knowledge is being only gradually brought together. For example, the iron-ore resources of South Australia are briefly dealt with in three pages, while the actual ore reserves are put down as nearly 68 million tons, and the probable and possible reserves are together estimated at 621 million tons. Since the publication of the Bureau's work the Geological Survey of South Australia has published a Bulletin (No. 9) upon the iron-ore resources of South Australia, in which an excellent detailed description of the various deposits is given, and it is shown that one alone of these contains ore reserves above the level of the surrounding country equal to 133 million tons, while various other important deposits are also described. Obviously no blame attaches to the Bureau, seeing that the data in question were not available when it prepared the part dealing therewith for publication. The instance is only quoted to show that even with a thoroughly careful compilation, like the one before us, the last word has not been said, and that our Imperial resources of iron ore are, in fact, greater than the present work indicates, simply because there are no doubt important ore-bodies yet to be discovered.

As regards the United Kingdom, there is little new to be said; the work of the Bureau was mainly to summarize the elaborate reports of the Geological Survey in a form more convenient for the ironmaster, and to supply all necessary statistical information. In this connexion, attention may be drawn to the very useful tables of the production, imports, and consumption of iron ore for each of the years 1909 to 1919, which have been arranged in a somewhat novel form, so as to show easily the movements of the world's ore supplies.

The portions of the work which no doubt ironmasters, and, it is to be sincerely hoped, also iron-workers will study most earnestly

are those which indicate the possible developments in iron manufacture in our overseas Empire. No small portion of our iron and steel industry has been engaged in supplying British dependencies, but there are significant indications in the volume before us that the more important of these will not only ere long be self-supporting but may even compete with us in the world's markets. Canada has long been an iron producer, the writer having been engaged in working the first coke blast-furnace in Canada as far back as 1877; but it is noteworthy that the Canadian output of pig-iron has more than trebled between the years 1909 and 1920, having risen from nearly two million to over six million tons, while during the same period the steel output has nearly doubled. In India iron manufacture on modern lines commenced in a small way rather over thirty years ago; in 1909 the production of pig iron was under 40,000 tons, in 1919 it was nearly 320,000 tons, or eight times as great, and in addition to the two iron works then in existence a number of others are under construction. India is already an exporter of iron and steel to other countries. In South Africa little has as yet been done; a couple of small experimental blast-furnaces were erected in South Africa in 1918, and these proved that coke made from local coals was quite satisfactory for iron-smelting. It is here shown that the Union of South Africa possesses an ample supply of good iron ores, and at the present moment the Newcastle Iron and Steel Company, Ltd., is erecting its plant at Newcastle, Natal, and the South African Iron and Steel Corporation, Ltd., is preparing to erect works near Pretoria.

It need hardly be said that, given an abundant and reasonably cheap supply of good iron ore, the dominating item that determines the position of any iron-producing country in the world's markets is the price at which the iron industry can obtain its coal, and in India and South Africa coal costs barely one-quarter of what it does in the United Kingdom!

The Commonwealth of Australia has long been known to possess ample supplies of iron ore, and small blast-furnaces were working in New South Wales as early as 1848; it was, however, not till 1915, when the Broken Hill Proprietary Company started an important plant at Newcastle, New South Wales, that production on any considerable scale was undertaken. As a result the production of pig-iron, which was under 27,000 tons in 1909, rose to 344,000 tons in 1920; simultaneously the imports of pig-iron into Australia from this country fell from 40,000 tons to 2,000 tons, and in the last-named year Australia was even in the position to export pig iron.

This aspect of the iron-ore question is undoubtedly the one that presents the greatest interest, not only to ironmasters but to all inhabitants of Great Britain, and should give serious food for thought above all to British labour leaders. We in Britain live only by the exports of our mines and factories, and among these our iron and steel manufactures, depending as they do on coal and iron ore, stand in the front rank. This summary of the position of iron-ore production within the British Empire shows only too clearly that an era of strenuous competition is before us, that we shall be very far from the position of being able to control the foreign market and fix our own prices, and that we must learn to produce as cheaply as others, or go under. Naturally the competition will not be only with the other portions of the British Empire, but with the world at large, and it is impossible to say to-day whether those old competitors with whom we have long been engaged in industrial struggles, like the United States, or whether the new ones that are just looming up over the industrial horizon, like China, are most to be feared. Though we can hardly dare to say to-day that we face the future with confidence, we can at least extract some little consolation from the fact, which the present work brings out clearly, that in the iron industry our kith and kin overseas appear to be as well-equipped with the natural resources essential for the iron industry as any one else among the iron-producing countries of the world.

Reserves of United Kingdom

For the benefit of our many readers who are not specialists in the iron industry, we give in the following paragraphs an outline of the information contained in Part I of the report on iron ore referred to in the article by Professor Louis. This part is devoted to the United Kingdom, and contains 240 pages of carefully selected information and statistics. In future issues we intend to present similar résumés of the other volumes.

Iron Ores in General.—The chief ore-minerals of iron are the oxides, hematite and magnetite; the hydrated oxides or brown

iron ores, including limonite, goethite and turgite; and the carbonate, chalybite or siderite (spathic iron ore). Iron silicates, represented chiefly by chamosite, occur abundantly in many bedded ores. Sulphides of iron as such are of no value as iron ore, but the oxide (" purple ore ") remaining after pyrites has been roasted to drive off sulphur for the manufacture of sulphuric acid is used to a considerable extent in iron manufacture.

Magnetite, the black magnetic oxide of iron (Fe_3O_4), contains when pure 72·4% of metallic iron. Magnetite deposits are usually found in contact with or included in igneous and metamorphic rocks. When included in basic igneous rocks, such as gabbro, magnetite is usually titaniferous owing to intergrowth with ilmenite, this being a serious disadvantage. Other common impurities are silicates and apatite (the latter containing phosphorus), from which, however, the magnetite can often be readily separated by reason of its magnetic character. The presence of silicate and other impurity causes the percentage of iron in crude magnetite ores to vary considerably. Thus, the general range of composition in magnetite ore shipped from Sweden is from 58 to 69% of iron, 0·02 to over 2% of phosphorus, 0·02 to 0·12% of sulphur, and about 2 to 10% of silica.

Hematite, the red sesquioxide of iron (Fe_2O_3), contains when pure about 70% of metallic iron. When free from included magnetite, it is comparatively non-magnetic, and is thus, as a rule, less amenable to improvement by magnetic concentration; but it is frequently found as large beds and masses of good quality, and is less liable to contain crystalline silicate and apatite impurity such as occurs so abundantly in many magnetite deposits.

Brown iron ores, including limonite ($2Fe_2O_3$, $3H_2O$), goethite (Fe_2O_3, H_2O), and turgite ($2Fe_2O_3$, H_2O), are hydrated sesquioxides of iron containing respectively about 14½, 10, and 5¼% of water when pure, the percentages of metallic iron being about 60, 63, and 66 respectively. These ores occur usually as bedded masses, but also as alteration products of other iron minerals.

Chalybite, siderite, or spathic iron ore, is the carbonate of iron ($FeCO_3$). It is liable to admixture with other spathic minerals, especially calcium, magnesium, and manganese carbonates. Many of the carbonate ores, however, are oolitic rather than spathic, and this kind of ore frequently contains some form of hydrated silicate of iron and aluminium, of which chamosite is the most common.

Although all common iron minerals contain a large percentage of iron when pure, the deposits actually worked usually contain also a considerable amount of impurity and correspondingly less iron than the pure mineral. As a general rule, material containing more than 20% of metallic iron may be termed iron ore, and the percentage may range up to about 70%.

Iron ore occurs in many different ways, some types of deposit being of comparatively little importance from an economic point of view. The principal types are as follows:—

1. Igneous segregations.
2. Contact-metamorphic deposits.
3. Vein deposits.
4. Superficial residues due to weathering.
5. Bog and lake ores of recent formation.
6. Bedded ores, metamorphosed in some cases.
7. Replacement deposits.

Of these various types of deposit the bedded ores are by far the most important, constituting probably more than 60% of the world's total reserves. The remaining deposits are chiefly of residual or replacement origin. Others, including igneous segregations, contact and vein deposits, and bog or lake ores are comparatively unimportant. Even assuming the magnetites of Northern Sweden to be igneous segregations, these constitute a comparatively small percentage of the world's reserves; and although, if titaniferous iron ores were to be included, this type of deposit would figure more conspicuously, it is not likely to attain an importance comparable with that of the bedded ores.

Iron ores occur in rocks of all geological ages, but the bulk of the world's output of the ore is obtained from deposits in pre-Cambrian and Jurassic rocks. In the United States, the leading producer of iron ore, Lake Superior ores, which are of pre-Cambrian age, contributed 85% of the total output of that country in the years 1913 and 1919. Next in order of importance as a producing area is the Lorraine region of France. Of the total production of iron ore in France, Germany, and Luxemburg in 1913, the Jurassic ores of the Lorraine region contributed about 85% of the total output of those countries. In Great Britain, which ranks third as a pro-

ducer, the Jurassic ores of the Cleveland district and the Midlands contributed over 75% of the total output of the country for 1913. Sweden, which comes fifth in order of importance, obtains almost the whole of its output from pre-Cambrian rocks. Of other deposits producing annually more than a million tons of iron ore, those of Spain and Algeria are Cretaceous limestone replacements; those of Austria are Triassic limestone replacements, and those of Cumberland and Lancashire, in England, are largely Carboniferous limestone replacements, whereas those of Newfoundland are bedded deposits of Cambrian age. Among deposits of recent geological age, those formed by weathering processes now in operation are of much interest, as, for example, the lateritic iron ores of Cuba, which are remarkable for the chromium and nickel they contain. Similar deposits occur in various other parts of the world. In some places where surface deposits of lake iron ores are being worked these are actually forming almost as rapidly as they are being exploited. Examples of these are the lake ores of Sweden and Finland, which are being precipitated sufficiently rapidly to add considerably to the life of the deposits at the present rate of exploitation. As regards the nature of deposits in relation to their mode of occurrence, it may be remarked that most of the bedded deposits of the world, the Jurassic, for example, are phosphoric, whereas the non-phosphoric ores are usually of the replacement type, examples being the Cumberland, Spanish, and Algerian hematites. In view of the fact that such a large proportion of the world's iron ore deposits are of pre-Cambrian age, and the bearing of this fact on the world's potential resources, it may be pointed out that the extensive deposits of Brazil, as well as those recently discovered and developed in the Singbhum district of Bihar and Orissa, in India, are in pre-Cambrian rocks. This would appear to indicate that the hitherto imperfectly explored portions of the pre-Cambrian tracts of the earth's surface, such as those of north-eastern Canada and the western portion of Australia, are likely to contain important deposits as yet undiscovered.

Next to the total iron content of an ore, it is important to consider the effect of gangue matter, or slag-forming constituents. Generally speaking, where the gangue of ore is calcareous, or where an ore contains a considerable percentage of lime, it is usual to consider the ore in effect as equal to a mixture of limestone and normal ore. The contained lime is taken to be equivalent to twice as much limestone. After such an allowance upon these ores, the remainder of the ore, like the generality of ores, consists of iron oxide and gangue which is primarily siliceous. Any increase of siliceous gangue leads to an increase in the fuel and flux used per ton of pig. Also as the iron content of ore falls, more and still more ore is required per ton of pig, which leads to a progressive increase in siliceous gangue, and the requirements of flux and fuel also increase progressively. It thus follows that the ratio of iron to silica in an ore has a most important bearing upon ore value. As this ratio falls in numerical value the ore progressively diminishes in value. It may be generally stated that when the ratio of iron to silica falls appreciably below 2 : 1 it requires to be very favourably situated as regards carriage, cost of fuel, flux, etc. This ratio is a very important factor in ore valuation. Ores in which the phosphorus is below 1/2,000th of the iron content, which can be wholly used for hematite pig iron, are of better value than similar ores of more phosphoric nature, because the pig iron obtained from them generally commands better price than the more phosphoric iron. Ores bordering upon but slightly above the hematite limit, although not wholly suitable for use to make hematite iron, usually bear some relationship to the higher value for use in mixing. Manganese above about 2% of the iron content is generally speaking detrimental to ore for hematite iron and iron for foundry purposes, although not at all disadvantageous in ore for making basic iron. Where the basic Bessemer process is operated, fairly considerable amounts of manganese and phosphorus may be even advantageous. It is necessary that an ore should be reasonably low in sulphur, although sulphur can be dealt with at some cost, but not so readily if it exists in the ore as pyrites. Tangible amounts of arsenic, copper, and chromium, larger amounts of nickel, cobalt, or titanium, and still larger amounts of zinc and lead, are disadvantageous to iron ore for ordinary blast-furnace use.

Production and Imports.—Table I overleaf gives an idea of the production of iron ore in the United Kingdom in 1909 and 1919, together with the imports from other countries. In reading this table it is necessary to remember that the imported ores are richer in iron than the domestic ores. The

average Swedish ore runs 58 to 69% iron and Spanish hematite 50%, as against 32% or less in the English Jurassic ore.

TABLE I.—PRODUCTION AND IMPORTS OF IRON ORE. UNITED KINGDOM.

	1913 Long Tons	1919 Long Tons
Production	14,804,000	12,254,000
Imports—		
Newfoundland	62,000	
India	3,000	-
Belgium	15,000	- -
France	119,000	33,000
Germany	2,000	
Greece	261,000	27,000
Italy	7,000	
Norway	186,000	97,000
Russia	35,000	2,000
Spain	4,726,000	3,525,000
Sweden	290,000	207,000
Algeria	482,000	723,000
Tunis	108,000	293,000
Total Imports	6,326,000	5,201,000
Total Production and Imports	21,804,000	17,455,000
Output of Pig Iron	9,532,000	7,417,000

OCCURRENCE OF BRITISH ORES.—The volume then gives an outline of the geological occurrences of iron ores in the United Kingdom. Table II contains in condensed form a general outline of these occurrences.

By far the largest deposits now worked are found in the Jurassic rocks, but these contain only a low percentage of iron and a relatively high percentage of phosphorus. In certain favourably situated localities some of these deposits were extensively worked before the war, and during the war the difficulty of importing sufficient quantities of foreign ores containing a higher percentage of iron and very little phosphorus stimulated the development of these deposits and encouraged the use of phosphoric ores in the manufacture of steel by the basic process.

The Coal Measures contain large amounts of ironstone in numerous thin beds and nodules, and these supplied the bulk of the ore used in the early days of the iron-smelting industry.

The deposits of hematite ore found in the Carboniferous Limestone strata of Cumberland and North Lancashire, while not extensive or cheaply worked, continue to supply a moderate quantity of high-grade ore.

RESERVES.—Tables III and IV give an estimate of the available reserves in Great Britain. The Jurassic ores occur mainly in the Lower and Middle Lias, the Inferior Oolites, and the Corallian. In every case the outcrop of the ore-bed can be traced, and the part of it which is workable determined. Its horizontal extent underground as a payable ore remained an uncertain factor, and this has partly been determined by recent mining exploration, on which estimates of quantities can be based.

TABLE II.—TABLE OF FORMATIONS

	Lower Cretaceous	
Lower Greensand and Wealden.	Sand and sandstone, clay, limestone, marlstone, etc.	Ferruginous sands and marlstone rather abundant. Formerly worked in Lincolnshire and Wiltshire; also nodular ironstone in the Weald.
	Middle Oolites	
Corallian Beds ..	Limestone, marls, and clays.	Sometimes ferruginous. Ores of Westbury, Abbotsbury and Kent.
Kellaways Rock	Sandstone more or less ferruginous.	Doubtful if of any value; East Yorks. and Kent.
	Lower Oolites	
Great Oolite Series	Limestones, sandstones, and clays.	Some thin ironstone bands not now worked.
Inferior Oolite Series.	Do. Do.	"Top Seam" of Cleveland ironstone. Northampton ironstone of Midlands.
	Lias	
Upper Lias......	Clay shales and thin limestone.	Nodules only: of no economic value.
Middle Lias....	Shale, marlstone, and ironstone.	Main seam of Cleveland; Ironstone of South Lincolnshire, Leicestershire and Oxfordshire.
Lower Lias.....	Shale, limestone, and ironstone.	Frodingham ironstone of North Lincolnshire.
	Trias	
Keuper	Sandstone and marl.	Pockets of iron ore in Gloucester, Somerset, etc.
	Carboniferous	
Coal Measures .. Millstone Grit... Carboniferous Limestone Calciferous Sandstone		Clayband and blackband ironstones; Weardale spathic ore; bedded ores in Millstone Grit.
	Devonian	
		Ores of Devon and Cornwall.
	Ordovician	
		Pisolitic ironstone of Aber and Llandegai in North Wales.
	Cambrian	
		Pisolotic ironstone at Bettws Garmon in North Wales.

TABLE III.—RESERVES OF JURASSIC ORES IN LONG TONS

	Proved.	Estimated Total. Proved and Probable.
Lincoln	324,000,000	979,000,000
Wilts	26,000,000	48,500,000
Dorset	—	11,500,000
Kent	—	100,000,000
Northampton	507,000,000	1,654,900,000
Rutland	78,000,000	117,000,000
Leicester	30,000,000	45,500,000
Oxford and Warwick	36,000,000	355,000,000
Raasay	10,000,000	21,700,000
Yorkshire]	190,000,000	428,000,000

TABLE IV.—OTHER RESERVES

Carboniferous Bedded Ores of Yorkshire, Derby, Nottingham, Stafford, South Wales, Scotland, etc.	1,049,497,000	7,716,272,000
Hematites of Cumberland and Lancashire	45,000,000	103,300,000
Other Deposits	—	90,736,000

The reserves, also, of the Coal Measure ore, which formerly were most important sources in Great Britain, are calculable, but the output of the ores has so dwindled, owing to the exploitation of the best seams, and also by reason of the competition of the cheap imported ores of higher grade, that the work entailed in making detailed estimates has

not as yet seemed justifiable. As regards the reserves of hematite and other ores in lodes and pockets, the locality and extent of new pockets cannot be predicted with precision. In the case of the hematite deposits of Cumberland and Lancashire, the association of the ores with lines of fault, with certain beds of the Carboniferous Limestone cut by the faults, and with the former distribution of the Permian and Triassic rocks, has been established over what may be called the visible ore-field. Other tracts where the Permian or Triassic rocks still exist, and where the presence of the limestone may be inferred, on geological reasoning, to underlie them under suitable conditions, are regarded as concealed ore-fields. Estimates can be made of their contents on the assumption that they contain ore in the same proportion as the ore-fields already worked.

In the Forest of Dean, pockets of brown iron ore and hematite occur in the upper part of the Carboniferous Limestone Series, which crops out round the greater part of the coalfield. By operations carried on since the Roman occupation of this island, their existence has been proved over a part of the outcrop, and for this part a calculation of the reserves has been found possible. On the other hand, how far the ore-bodies extend, and whether they are equally abundant beneath the coalfield, has not been ascertained, and for this concealed ore-field no estimate is attempted. It remains as a possible but unknown reserve. There is, however, evidence to indicate that the quantity of ore gets less the deeper it is followed.

In Glamorganshire hematite occurs in the upper part of the Carboniferous Limestone, and its formation appears to be due to the former covering of Triassic rocks. As in Cumberland and Lancashire, there exists in Glamorganshire a visible ore-field, which has been partly exploited ; and a field concealed by red rocks, as yet little exploited, but regarded as being of considerable promise.

Estimates of the reserves in the Carboniferous Limestone in concealed fields are based on a consideration of the area over which suitable geological conditions extend, and on the assumption that the proportionate yield will be the same as that of the ground already worked.

Few of the vein deposits are being worked, some having been worked out, others exhausted to water level, but that several contain reserves of ore is certain. The estimate is based in such cases on the assumption that, in the aggregate, the veins contain a reserve of ore equal to the aggregate output of the last ten years, or in some cases the last 20 years, of the mining operations. This basis, arbitrary as it is, leads to an estimate bearing some relation to the proved productiveness of past years.

No ironstone containing less than 20% of iron has been included in the estimates.

SOURCES OF ORES SMELTED.—The following summary (Table V) showing the percentage distribution of the British iron ore production in 1918 is from information supplied by Dr. F. H. Hatch :—

TABLE V.—SOURCES OF ORE SMELTED

	%
Cumberland and Lancashire (hematite ore)	10·3
Northamptonshire and Rutlandshire (Inferior Oolite ironstone)	23·1
Cleveland district (Middle Lias ironstone)	30·2
South Lincolnshire, Leicester and Oxfordshire (Middle Lias ironstone)	10·0
North Lincolnshire (Lower Lias ironstone)	17·5
English and Scottish Coalfields (blackband and clay ironstone)	7·5
Raasay (Lias ironstone)	0·6
Wales (hematite and brown iron ores)	0·5
Forest of Dean (hematite and brown iron ores) ...	0·1
Weardale (spathic ore)	0·1
Antrim, Ireland (Tertiary ores)	0·1
Total	100·0

Taking the Jurassic ironstones in descending order, their iron contents are as shown in Table VI.

TABLE VI.—IRON CONTENTS OF JURASSIC IRONSTONES

	%
Inferior Oolite (Northampton and Rutland)	32
Middle Lias (Cleveland)	28
,, ,, (S. Lincs, Leicester, and Oxford	25
Middle Lias (Raasay)	23
Lower Lias (North Lincolnshire)	23
	27·6

CONCLUSION.—The information reproduced in the preceding paragraphs is collected from the first thirty-three pages of the report ; the remaining 207 pages are devoted to detailed descriptions of the various deposits.

The Institute of Metals

The autumn meeting of the Institute of Metals will be held at Swansea from September 19 to 22. A large number of papers are to be read, of which the following may be mentioned :—Sixth Report of the Corrosion Research Committee of the Institute of Metals, on "The Nature of Corrosive Action and the Function of Colloids in Corrosion," by G. D. Bengough and J. M. Stuart ; a report of the Aluminium Corrosion Research Sub-Committee of the Institute of Metals, on "Experiments on the Oxide Method of Determining Aluminium" ; the "Antimony-Bismuth System," by M. Cook ; the "Copper-Rich Aluminium Copper Alloys," by D. Stockdale.

LEACHING WITH SULPHUR DIOXIDE

By CHARLES E. VAN BARNEVELD and EDMUND S. LEAVER

The authors describe a method of treating oxidized ores of copper as developed by them at the South-West Experiment Station of the Bureau of Mines, Tucson, Arizona.

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INTRODUCTION. — The process here described was devised to provide a cheap and efficient method for treating the so-called "porphyry" copper ores of the South-West which generally contain both "sulphide" and "non-sulphide" copper minerals, mixed in such proportions that they can only be satisfactorily treated by a method which will concurrently recover both the sulphide copper and the non-sulphide copper. The latter term has been adopted to include all the minerals commonly referred to in operating phraseology as "oxidized," "oxide," or "soluble" copper. We believe that the sulphur dioxide leaching process, as developed by us with the co-operation of the Miami Copper Co. and the Arizona Copper Co., is suitable and commercially available for a wide range of ores.

PRELIMINARY INVESTIGATIONS.—A survey of milling and leaching practice in the South-West was made, preliminary to beginning active work on the problem in January, 1918. Our conclusions regarding the status of practice and research in this field in the winter of 1917–18 may be summarized as follows :—

(1) Flotation was developed to a high degree of efficiency and offered a satisfactory method of separating from their gangue clean sulphide minerals that had been crushed to the point of liberation, and converting them into a high-grade concentrate suitable for further reduction by smelting.

(2) Sulphuric-acid leaching followed by recovery of dissolved copper by electrolysis was a demonstrated success on completely oxidized ores, though plant investment was very high and there were operating difficulties. At least three other companies contemplated an extensive research programme of sulphuric-acid leaching on "mixed" ores and on tailing of varying composition, such as ores high in acid-soluble lime gangue, ores containing other acid-soluble constituents that would tend to excessively foul the leaching solutions, etc. Apparently, research in sulphuric-acid leaching and electrolytic precipitation of dissolved copper had been well provided for.

(3) The outlook for a successful all-flotation process based on filming or sulphidizing the oxidized minerals was not promising. Operations on a semi-commercial scale had demonstrated the unreliability of laboratory-scale tests, and the extreme sensitiveness and delicacy of the operation when conducted on a semi-commercial scale.

(4) Roasting-leaching had been carefully considered, and this line of research had been followed to the point of elimination of roasting-leaching in one form or another as a commercial probability in this territory.

(5) There still remained the field of sulphide leaching, important more particularly as regards massive sulphide ores with low copper content, since the hope of developing a sulphide copper leaching process to compete with flotation and smelting on the sulphide content of "mixed" ores was very remote.

(6) It seemed, in view of the past activity of the well-organized research staffs of the copper companies and the varied contemplated programmes, that the field was pretty well covered and that the opportunity for independent research was limited. Yet the fact remained that the "mixed" ore treatment was still unsolved, and that the net results of large-scale experimental work had proved generally disappointing. What had always seemed to us to be a very promising field for research—leaching with hot sulphur dioxide gas—had been neglected.

Considerable small-scale laboratory work was done at the South-West station to determine the behaviour of SO_2 with the various ores under consideration, and the conclusion was reached that comparatively fine grinding would be necessary. All the indications pointed to a flow-sheet that should include the following steps : Fine grinding to the point of liberation of sulphides ; leaching with hot SO_2 gas countercurrent to the pulp flow, SO_2 to be derived from the nearest available source, such as iron pyrites ores, chalcopyrite or cupriferous iron pyrites concentrate with high sulphur content ; flotation of sulphides, either before leaching or after leaching ; precipitation of dissolved copper on iron, this iron to be comparatively fine sponge iron, preferably to be prepared

locally by deoxidation or metallization of the iron-oxide residue from the roasting operation which furnished the SO_2 gas; recovery by flotation of the precipitated copper and of any sulphide copper remaining in the pulp. It was accordingly decided to provide equipment in the South-West Experiment Station for SO_2-leaching and flotation on a scale which would permit a range of leaching operations from hand samples to a maximum of perhaps one ton per hour.

While the process is called an SO_2-leaching process, it is in no sense an offshoot or development of the early Neill-Burfeind leaching process (see *Engineering and Mining Journal*, 1904, vol. 77, p. 400, and 1908, vol. 85, p. 821), or of later modifications thereof, which involve the retention of all dissolved copper in solution as copper sulphite, a notoriously unstable compound, to be later precipitated as cupro-cupric sulphite (Cu_2SO_3, $CuSO_3$). Instead, it is a continuous leaching process, controlled to form solutions of copper sulphate direct from oxidized copper ore ranging in fineness from 20 to 48 mesh, pulped with water containing the usual proportion of reclaimed mill liquid, treated countercurrent with dilute SO_2 roaster gas containing a large excess of oxygen over the amount necessary to completely oxidize all sulphides formed. Thus all difficulties met with in the aforementioned processes from the formation of unstable complex copper salts are avoided. No attempt is made to regenerate the leaching solutions; the sulphur supplied finally goes to waste as sulphates of the acid-soluble constituents of the ore, and as iron sulphates formed during precipitation of dissolved copper on iron.

Sulphur dioxide made from any convenient source, such as native sulphur, massive pyrite, or concentrate carrying upwards of 20% sulphur, may be utilized. If smelter gases containing 2% SO_2 by volume are available, they may be utilized direct from the stack. The ordinary volatile impurities found in smelter gases, such as arsenic and antimony, are not detrimental in this application of SO_2-leaching.

The earlier work done at the Tucson experimental plant contemplated the formation of H_2SO_3 in the pulp with the idea that the reactions involved would be limited to the formation of sulphites of the SO_2-soluble minerals, followed by rapid and complete oxidation of unstable sulphites to stable sulphates by the large volume of oxygen carried in the roaster gases. With precipitation of dissolved copper on iron an interchange is effected and a corresponding amount of iron is taken into solution as ferrous sulphate. In the earlier work at Tucson and also in that at Miami and Clifton, hereinafter described, no attempt was made to reclaim and re-use any portion of these solutions; the tailings were run to waste. Later experiments at Tucson, wherein current mill practice with respect to re-use of reclaimed water was followed, precipitating on iron and returning 40 to 60% of barren solution for another leaching cycle, revealed the fact that the sulphate of iron taken in solution during precipitation formed H_2SO_4 during the leaching cycle. This H_2SO_4 proved to be a better solvent than did H_2SO_3 for the resistant copper silicate ores in which the copper occurs as dilute solid solutions of copper silicate in quartz. The process can be controlled at will to regulate the amount of H_2SO_4 formed; moreover, this H_2SO_4 is produced without additional expense. The most resistant silicates are readily dissolved.

We early realized the difficulty of ensuring sufficiently prolonged contact between the ore particles in a large mass of ore with a gaseous reagent as SO_2 or with an unstable acid as H_2SO_3. Much thought was given to the best form of apparatus. The Nevada-Douglas Consolidated Copper Co.'s plant at Ludwig, Nevada, was visited in 1917 and a study was made of the experiment there carried on under the direction of Geo. C. Westby. (See *Engineering and Mining Journal*, 1917, vol. 104, p. 119.) We were impressed with the value of this demonstration of sulphatizing leaching with weak sulphurous gas; also we were impressed with the necessity for replacing the tower system with more efficient, more easily controlled apparatus.

The instability of H_2SO_3 is well known. The SO_2 is easily expelled by bubbling air through the SO_2 solution (H_2SO_3). Another easy way of effecting this expulsion is by heating the solution; at temperatures above 50° C. the absorption of SO_2 is practically negligible. This property suggested the possibility of utilizing in one continuous operation the solvent action of SO_2, the SO_2-expelling effect of air and heat upon SO_2 solutions, and the oxidizing effect of oxygen on sulphites, thereby developing a continuous countercurrent SO_2-leaching process which would use hot roaster gas for

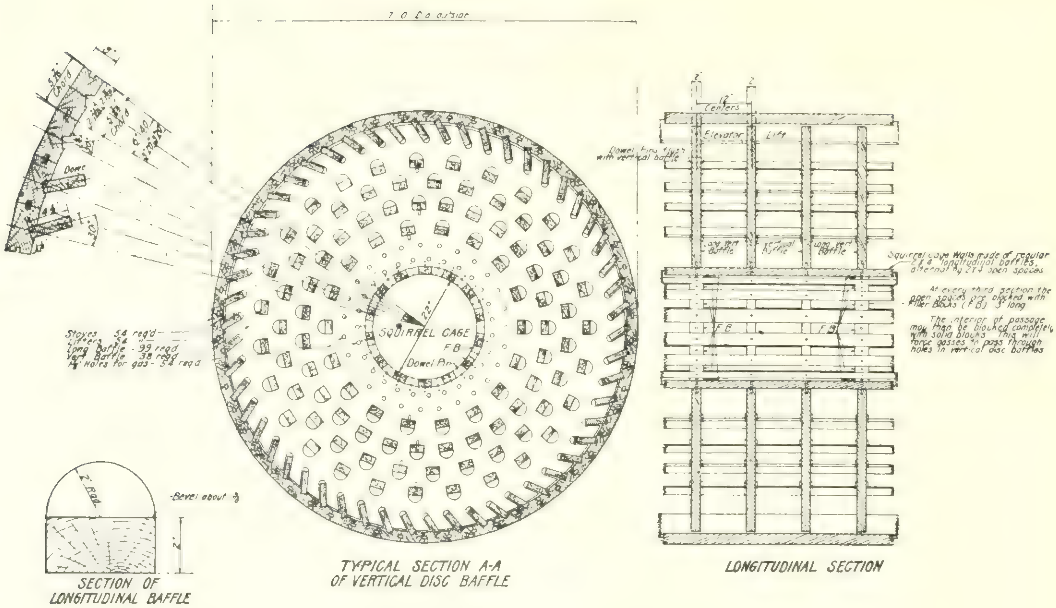


FIG. 1.—DETAILS OF DRUM BUILT BY THE MIAMI COPPER COMPANY.

leaching reagent and would discharge a practically neutral pulp containing all the soluble copper in the form of sulphate.

The ideal apparatus in which to effect dissolution would be one that would subject the thinnest imaginable sheet of pulp of the right consistence to a large excess of reagent in both gaseous and solution form, for the necessary time to ensure contact between the reagent and every ore particle. After carefully considering different types of apparatus, including various modifications of the tower system, a revolving drum was finally adopted.

TUCSON EXPERIMENTAL PLANT.—The Tuscon experimental SO_2-leaching plant originally comprised a pulping tank, a specially designed leaching drum and a Herreshoff roasting furnace, rated capacity 500 to 1,000 lb. of low-grade "mixed" copper ore per hour. The drum, 4 ft. in diameter and 16 ft. long, inside dimensions, is made of wooden staves and rotates slowly on a horizontal axis. The drum is supported by its steel tyres on a pair of flanged trunnions and is driven by a belt. The inner periphery of the drum is provided with lifters, on the plan of the South African tailings wheel; these act as elevator buckets and in their ascending movement caused by rotation of the drum they pick up the pulp and finally spill it on to a series of staggered horizontal baffles placed below the lifters in such manner that the ore pulp is splashed and distributed over the surface of the bars in fine descending drops and particles. The length of the drum is divided into 12 in. compartments by a series of transverse partitions, hereafter referred to as vertical disc baffles. These partitions have openings through which the 2 by 4 in. longitudinal baffles pass the full length of the drum. These openings are enlarged so that immediately above each baffle there is a semi-circular opening through which the pulp and the gases travel countercurrent to each other. Reference to Fig. 1, which shows construction details of a drum of similar construction, but of larger diameter, built subsequently by the Miami Copper Co., will make this clear. The "squirrel-cage" is a manway through which workmen may attain access to the interior of the drum. The Tucson experimental drum is too small to include this feature.

The ore may now be followed in its passage through the drum. The ore, ground to 30-mesh or finer, is pulped in the pulping tank to proper consistency; the ratio of water to ore may vary from 1:1 to 4:1. It is fed into the drum and drops to the bottom of the first compartment. The drum rotates slowly, and the lifters pick up their load and elevate it. The longitudinal baffles are so

situated with reference to the lifters as to cause the greatest possible amount of splashing of the pulp when the lifters begin to spill. The pulp is splashed and distributed over the surface of the horizontal bars and against the transverse partitions or vertical disc baffles, in fine descending drops and particles, thus ensuring intimate and prolonged contact between ore particles and the countercurrent sulphurous and oxidizing gases. Under the influence of a constant feed into the drum, a flow is established within the drum, so that the pulp is gradually passed through the successive compartments into the last or discharging compartment. The lifters in the last compartment raise the pulp and drop it into a discharge or exit pipe whereby it is conducted through a trap opening into the discharge launder. Some of the pulp spilled from the ascending lifters will find its way through the holes in the vertical disc baffles into the next compartment, only to be lifted to the top of this compartment and there to be subjected to the same showering action, and so on, through each compartment to the point of exit. The pulp enters one end of the drum cold. The reagent, consisting of heated combustion gases from the roaster, usually containing less than 4% SO_2 by volume for ordinary ores and a higher percentage of SO_2 for ores containing acid-soluble gangue minerals, enters through the top of the trap box, which is also the pulp discharge box. A countercurrent flow is developed which results in the pulp becoming progressively warmer and the gas becoming correspondingly cooler until the pulp at the discharge end is heated to any desired temperature. At a temperature of 50° C. the absorption of SO_2 is practically negligible. The hot pulp discharged from the drum at this temperature contains practically no free SO_2, and may be considered neutral. As the temperature decreases, the absorption of SO_2 throughout the drum progressively increases.

The requirements for good operating conditions of the drum may be summarized as follows :—

(1) Sufficient SO_2 must be introduced to effect rapid dissolution and at the same time sufficient oxygen must be present to effect rapid oxidation of sulphites to sulphates.

(2) Sufficient sulphur (in whatever form) must be burned to heat the gas to the point which will produce the desired terminal pulp temperatures.

(3) The density of the ore pulp will be one limiting factor in the capacity of the drum since, for any given temperature and volume the furnace gas, the temperature of the pulp at discharge will vary inversely as the volume of solution which the gas must heat.

(4) Thus for each particular case there is a proper relation between pulp density, admission temperature of gas, dilution of gas, and leaching efficiency, which will determine the quantity of pyrite to be burned. Approximations may readily be made in each case from a knowledge of the conditions ; subsequent regulation of the variable conditions is a simple matter ; from this the requirements may be accurately determined and positively maintained.

(5) It may be assumed that very seldom will a greater dilution than $1\frac{1}{2}$: 1 (water to ore) be necessary to obtain the proper conditions for rapid dissolution, while in many cases a 1:1 pulp will be found satisfactory.

(6) The pulp issuing from the leaching drum must be aerated to oxidize any sulphites and to remove any remaining SO_2 gas. This is a pre-requisite to successful recovery of dissolved copper by precipitation on iron and flotation of cement copper.

(7) The process is easily controlled ; it has no critical points ; no fine adjustments are required. Ordinary intelligent supervision and attention to half a dozen simple details are needed. Proper crushing is important. Quantity of feed may vary within reasonable limits ; regularity of feed is desirable. The gas is easily controlled as to volume, SO_2 content, and temperature. An essential condition is the constant maintenance within the drum of a slight excess of SO_2 over the requirements of the acid-consuming constituents of the ore. The temperature of the leaching pulp at discharge affords a quick method of detecting changes in roasting-furnace product or in reactions within the drum. This temperature should be tested at 30-minute intervals. The pulp should be tested hourly for SO_2 content, both at exit from the drum and after passing the blower tanks. Uniform pulp density should be maintained and the density should be regularly tested. Seven operations are required for plant control ; these have been standardized and reduced to simple routine operations.

Four methods of recovering copper from sulphate solutions are available :—

(1) Decantation and precipitation of copper on iron from clear solution.

(2) Partial decantation and filtration followed by precipitation on iron.

(3) Precipitation on iron in the pulp, the cement copper to be recovered by flotation.

(4) Decantation or filtration of the pulp and electrolysis of clear solution. This method regenerates sulphuric acid solution for leaching, which, however, is not of great importance in a process where the solvent is so cheap as it is in SO_2-leaching. Solutions so far obtained on South-Western ores have varied in copper tenor from 0·3 to 1·0%, too low a range for electrolytic precipitation. The copper content of solutions would therefore have to be built up by grinding with pregnant solution in acid-proof pebble-mills.

Tailings from the oxidized ores common to this section have a tendency to settle slowly, therefore recovery method No. 3—precipitation on sponge iron in pulp followed by flotation of cement copper—seemed promising, and much of the test work done has been carried on with this in view. However, this method of recovery is by no means essential to the application of the SO_2-leaching process. Several promising continuous centrifugal filters now proposed offer decided encouragement in the matter of handling slimy ores. The flotation of cement copper is a problem which has not as yet been solved on a commercial scale. Several points require attention, involving physical condition of precipitant, presence of certain salts in solution, necessity for ensuring complete oxidation of sulphites and expelling all SO_2 from flotation pulp. There is warrant for the opinion that the solution of the problem is merely a question of working out minor details.

The first experimental work at Tucson was done on a 20-ton scale on the most readily available material, namely, oxidized mill tailings remaining from former operations of the Detroit Copper Co., the Arizona Copper Co., and the Shannon Copper Co., in the Clifton-Morenci district. A carload of these old mill tailings, which assay from 1·00 to 1·25% total copper and from 0·48 to 0·75% non-sulphide copper, was shipped to Tucson by the three companies interested. Leaching results on this material were very satisfactory. A tailing containing from 0·04 to 0·06% soluble copper was maintained. Thereafter a test was made on a sulphide flotation tailing sample of several tons specially prepared by the Miami Copper Co. As a result of these tests co-operative agreements were entered into, first with the Miami Copper Co., and later with the Arizona Copper Co.

MIAMI TESTS.—The Miami tests were carried out in a drum 7 ft. 4 in. by 40 ft. in size, and having a rated capacity of 100 tons per 24 hours. A 10 ft. six-hearth Herreshoff roasting furnace supplied SO_2 gas by roasting about 2½ tons per 24 hours of massive pyrite, containing 44% iron and 50% sulphur, down to less than 2% sulphur. This furnace could readily have supplied SO_2 gas for a leaching drum of 250 ton capacity. A No. 8 Buffalo blower conveys the gas from roasting furnace to drum intake. The actual power consumed in operation of the entire plant is less than 20 h.p.

The flow-sheet comprises the following steps: ore-bins, capacity 350 tons, ore crushed to ½ in.; cut-out in the launder from bin to ball-mill to permit weighing of ore flow; Hardinge mill in circuit with Dorr classifier, set to discharge 48 mesh pre-oiled pulp, water to ore ratio 3½ : 1; pneumatic flotation unit of four roughing cells and one cleaner cell for flotation of sulphides; flotation tailing is thickened to 1½ : 1 water to ore ratio and fed to leaching drum; time of passage through drum about 40 minutes; drum discharge consisting of undissolved ore in copper sulphate solution passes to aeration cells for removal of SO_2 and oxidation of sulphides; thence to precipitating drum where copper is precipitated on iron balls; iron consumption 1·2 lb. per lb. Cu; fineness of cement copper varying from 200 mesh to 1,000 mesh; pulp as it discharges from precipitating drum is restored to former density by addition of the overflow from previous thickening operation; thinned pulp is floated in 3-cell pneumatic flotation unit for recovery of cement copper; flotation tailings to waste.

The Miami plant commenced operations in February, 1919, on a 2% ore carrying about 1% non-sulphide copper. The apparent leaching extraction obtained towards the close of the experiment on an average daily capacity of 100 tons, at a pulp density of 1·06 : 1, with 60% utilization of a gas containing 4·25% SO_2 by volume, was 80% of the non-sulphide copper.

The upper sulphide flotation plant was run in accordance with established practice, with uniformly satisfactory results. In the

lower flotation plant copper recovery was erratic; the average monthly recovery for the 11 months during which this plant was in operation varied from 54% to 82%. Three reasons exist for these poor cement copper flotation results.

(1) Improper precipitation. Precipitation on iron balls is quite efficient as regards precipitation, but the resulting cement copper is very fine; much of it will pass a 1,000-mesh screen. Laboratory tests indicate that copper precipitated on sponge iron is more readily flotable.

(2) Irregular feed. The Miami SO_2-leaching test plant was built during the war; it was necessary to use material on hand; several makeshift arrangements resulted, which caused considerable trouble in the operation of the plant. This is especially true of the pulp-thickening apparatus; the discharge plugs often clogged with chips, now retarding or stopping the flow, now "breaking through" in increased volume when the plugs were cleaned out, thus sending a large excess of feed to the leaching drum and upsetting the plant balance, the bad effect being most noticeable in the cement copper flotation. This happened many times during a shift.

(3) Free SO_2 or sulphites in the pulp. The presence of free SO_2, even in such small quantities as 0·04%, seriously affects flotation of cement copper. Sulphites, whether normal sulphites or bi-sulphites, are not in themselves detrimental, but bi-sulphites are quite unstable and may dissociate, when violently agitated, with liberation of SO_2 molecules; this may happen at any point in the process prior to complete oxidation; it might happen during precipitation or in any flotation cell. Confirmatory tests were made which indicated that the flotation difficulties often were due to the presence of sulphites, and these difficulties were accentuated when the pulp flow was irregular. With the plant in nice adjustment and under experienced supervision, almost perfect cement copper flotation was obtained at times; recovery by shifts frequently averaged above 90% of the precipitated copper. There is warrant for the opinion that with balanced leaching conditions, uniform pulp flow, complete removal of SO_2 and sulphites in the pulp, and with properly prepared sponge iron as a precipitant, to obtain good flotation would simply be a matter of adjustment and of experiment with reagents.

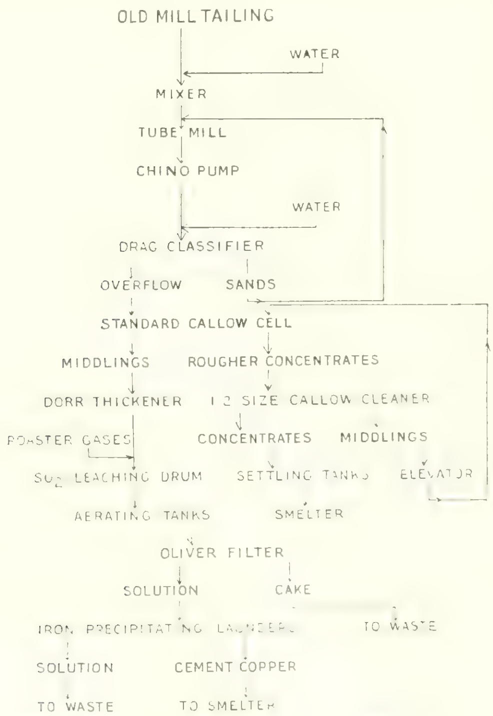
Suspension of Miami Experiment.—The Miami test plant was closed down for the following reasons; The non-sulphide copper lost in the tailing during the leaching period of September, 1919, to January, 1920, inclusive, varied from 0·19 to 0·20%, and the average apparent leaching recovery was 79·5%. The addition of sulphuric acid during January reduced the tailing loss to 0·10%, indicating that sulphuric acid is a better solvent than SO_2 for the resistant type of solid solutions of copper silicate.

While the Miami SO_2-leaching experiment was in progress, the Inspiration Consolidated Copper Co. erected a 30 ton experimental sulphuric-acid leaching plant. The two mines adjoin each other and the ores are very similar. The Inspiration ores have the advantage over the ores being treated by sulphuric-acid leaching at the New Cornelia Copper Co. plant at Ajo, Arizona, in that the amount of soluble iron in the Inspiration ore is negligible. The Inspiration research staff did not venture far afield outside of known practice. They took full advantage of available knowledge on the subject, with the result that they greatly simplified procedure and worked what appears to be a highly efficient and economical sulphuric-acid leaching process. Decided advance was made in electrolysis. The absence of impurities in the ore permits the use of a very dilute electrolyte containing about 1% copper as against 3% copper at Ajo. Furthermore, it was found possible to strip the discard solutions by electrolysis, thus avoiding the necessity of precipitation on iron, the entire product being electrolytic copper.

The great improvement of results at Inspiration over those at Ajo interested the Miami Copper Co. to the point of its deciding to undertake similar experiments on their ores, with this modification: They proposed leaching finely ground ore (48-mesh) as against coarse ore ($\frac{1}{4}$ in.) at Inspiration. This involved investigating the possibilities of filtration of acid pulp. It was decided to close down experimental work on SO_2-leaching. The Miami Copper Company's experimental campaign on sulphuric-acid leaching was interrupted by generally depressed industrial conditions before it could be brought to a conclusion.

Work with the Arizona Copper Co.—Experimental work begun in 1917 by the Arizona Copper Co. on mixed ores and tailings led to its building a 10-ton experimental

sulphuric-acid leaching plant at Clifton. (See *Engineering and Mining Journal*, 1920, vol. 110, p. 471.) Early in 1918 tests were made in the Tucson SO_2-leaching drum on old mill tailings from the Clifton-Morenci district. The results were sufficiently encouraging to induce the Arizona Copper Co. to build a 5 ft. by 20 ft. leaching drum following our design, and to fit this into the old experimental sulphuric-acid leaching-plant equipment. A 4 ft. six-hearth roasting furnace was added. SO_2-leaching was begun in June, 1920, and was carried on intermittently until April 1, 1921. After trying out various combinations, including sulphide flotation after leaching, the accompanying flow-sheet was finally adopted.



FLOW-SHEET OF SO_2-LEACHING PLANT AT ARIZONA COPPER CO.

The Shannon old mill tailing is a high acid-consuming material containing 0·60% of non-sulphide copper. During January, 1921, for each ton of Shannon tailing, 181 lb. of concentrate was roasted, containing 34·5% sulphur; 80% of this sulphur was expelled as SO_2 by roasting, and 66% of the SO_2 was absorbed in the drum. Reduced to terms of sulphur and copper this means 3·12 lb. of sulphur consumed per lb. of copper recovered, with an 81·36% extraction of the soluble copper. While no mill run was made on Shannon material during the sulphuric acid-leaching campaign, laboratory tests indicate that a 24-hour cold leach with 3% sulphuric-acid will recover 78·8% of the soluble copper with a consumption of 95·4 lb. of 100% sulphuric acid, or 31·1 lb. of sulphur, equivalent to 3·03 lb. of sulphur consumed per lb. of copper recovered, with a 78·8% extraction of the soluble copper. The comparison may then be stated as follows:—

40-min. hot SO_2-leach: 3·12 lb. S per lb. Cu; 81·36% extraction.

24-hr. cold H_2SO_4-leach: 3·03 lb. S per lb. Cu; 78·8% extraction.

Theoretically, 1 lb. of copper requires 0·51 lb. of sulphur; the excess sulphur is consumed by one or more of the acid-consuming minerals, such as soluble iron, lime, magnesia, and alumina. It has been demonstrated that a low-percentage acid leach will consume a smaller proportion of gangue minerals, yielding a cleaner pregnant solution, and requiring correspondingly less discard solution to reject "built-up" impurities. SO_2-leaching is necessarily a low-percentage acid leach, since it is not practicable to absorb over 1·5% SO_2 under the operating conditions that exist. The estimated cost of converting the sulphur in a concentrate, containing 600 lb. available sulphur per ton, into SO_2 and delivering the SO_2 into the drum is 0·17 cents per lb. of sulphur, while the cost of delivering sulphur in the form of 60° B sulphuric acid is 2 cents per lb. with acid costing \$10 per ton f.o.b. plant, and 1 cent per lb. with acid costing \$5 per ton. Parenthetically, it may be said that in many copper-mining districts iron pyrites ores having 800 lb. of available sulphur per ton are readily obtainable. A liberal allowance for the overall cost of raw material and of roasting expense is \$5 per ton, which would make the cost 0·625 cent per lb. of sulphur, delivered into the drum as hot SO_2 gas. Very few localities have come under our observation where local concentrate or local pyrites is not available.

The Clifton experimental plant was closed down on April 1, 1921, in accordance with the general retrenchment policy forced on the copper companies by industrial conditions, before the campaign originally planned had been completed. Many valuable lessons were learned during this experimental campaign: the adaptability of SO_2-leaching to these tailings and the relative economy

of SO_2 gas produced by roasting local concentrates over sulphuric acid at $5 per ton f.o.b. plant were demonstrated.

Tucson Experimental Work.—The Miami experiment fully demonstrated on a 100 ton scale the mechanical and metallurgical feasibility of SO_2-leaching with hot roaster gases. It also proved conclusively that the sample on which the original Tucson results were obtained was not representative, that a large proportion of the soluble copper in the Miami mixed ore occurs as a dilute solid solution of copper silicate in silica, and that this silicate is very difficultly soluble in SO_2 and more readily soluble in sulphuric acid. It was evident that more laboratory work would be necessary to solve the problem of dissolution of these refractory silicates. With the cessation of co-operative work at Miami and Clifton, attention was centred on this problem in the Tucson laboratories. The need for a pilot apparatus in which satisfactory laboratory tests could be made on a 10 to 50 lb. scale had long been apparent. Various Pachuca tanks and absorption tower combinations were tried and abandoned, as the results obtained in them were neither satisfactory nor representative. The apparatus finally evolved has for the past 12 months given continuous and satisfactory service (Fig. 2). Two drums identical in construction are used. They may be operated singly, or in series. The admission of air and SO_2 are under perfect control. The mixture of air and SO_2 is pre-heated as may be required to attain the desired leaching temperature; this is done by passing the mixture through iron pipes, which are externally heated by electric current. Limitations of small-scale construction prevented an exact reproduction of the interior drum arrangement; for instance, in order to have the necessary longitudinal baffles for proper spraying and splashing, it became necessary to reduce the size of the openings in the vertical disc baffle if there was to be any vertical disc left at all. These small openings clog proportionately more easily than the larger openings in the full-size drum. As a consequence, it became necessary to run the pilot-drum tests at 4:1 pulp density. The time of travel through this 9 in. by 36 in. drum is from 30 to 40 minutes. By comparing the results obtained in a single pilot drum reproducing the operating conditions of the Miami and Clifton drums and using the identical feed, we have satisfied ourselves that the pilot plant so closely approximates the work of the large plants that the results may be safely accepted as indicating what may be expected in actual commercial operations. We have also conclusively determined by comparative tests that the use of ordinary roaster gases does not introduce any complications which might produce results differing from those obtained by use of pure gas.

In both the Miami and Clifton experimental plants the barren leaching solutions remaining after precipitation were run to waste. Special provision would have been required to reclaim these solutions for re-use in the leaching circuit; the easier and cheaper course as regards test-plant construction was to send them to the mill pond. Generally, it is practicable to recover 60% of the water or solution from a milling or leaching operation. An ore containing 1% soluble copper, leached at 1:1 pulp density, followed by precipitation on iron, would yield waste solution containing 0·25% Fe as $FeSO_4$. By the use of 50% reclaimed solution, the leaching solutions would soon build up to 0·5% Fe. Had this practice been followed in the operation of the Miami drum, the discoveries made during the past nine months in the Tucson pilot drum would doubtless have been anticipated by two years, and the Miami experiment would have been an unqualified success. The observation of certain leaching effects in the Tucson pilot drum led to special research with a view to utilizing the drum as a convenient apparatus for making weak sulphuric acid. It was found that by special but simple control it was quite practicable to rapidly oxidize ferrous sulphate, in the presence of SO_2, to ferric sulphate; and that this ferric sulphate in turn reacts with SO_2 to form ferrous sulphate and sulphuric acid. Therefore, the operation of the pilot drum was controlled to include this reaction, with the result that the most resistant silicates are apparently readily decomposed in their passage through a short drum (36 in.), in which the pulp is retained from 30 to 40 minutes. A large number of tests were made on a wide range of ores, including ores that have soluble lime and other acid-destroying gangue minerals. In all cases a very low tailing was obtained.

Table I (page 153) offers a summary of results both on typical leaching ores and on ores whose acid-consuming gangue would ordinarily prohibit their consideration from

a leaching standpoint. In low-grade ores the extraction percentage may give an erroneous impression; the tailing assay is the better index to the efficacy of the treatment; therefore special attention is called to column 8, where the non-sulphide copper content of the tailing from the leaching operation is recorded. The typical data sheet below indicates the factors recorded in the control of the process.

Plans for 1922.—Plans for the immediate future include:—

(1) A continuous leaching-flotation campaign on three representative ores, flow-sheet to include: Leaching in the double-drum pilot apparatus; aerating the pulp discharge from the drum; precipitating on sponge iron made in our laboratory; recovery of cement copper by flotation in an eight-cell flotation unit now under construction in our laboratory, having the same capacity as the pilot leaching drum; reclamation of barren solution from flotation tailings, re-using varying proportions of this solution in pulping fresh ore to the point of stabilization of impurities.

(2) Continuation of experimental programme on making sponge iron from the residuary calcines after roasting pyrites or concentrate for the production of SO_2 gas as a leaching reagent.

(3) Leaching of sulphide copper ores and of copper-bearing concentrates.

Competing Processes.—In the beginning of this article brief mention was made of two very attractive potential processes designed to recover the entire copper content of mixed ores, namely, an all-flotation process and a roasting-leaching process. Both should be considered as possible future competitors of flotation combined with SO_2-leaching. The only demonstrated and standardized process which can compete with SO_2-leaching on the non-sulphide portion of mixed ores

TYPICAL DATA SHEET

Sample from Miami Copper Co.

ANALYSIS

	%		%
Insol. . . .	92·8	Sulphur .	0·6
Fe_2O_3 . . .	1·6	Lime (CaO)	0·2
Al_2O_3 . . .	1·0	Acid Consumed (H_2SO_4)	64 lb.

Oxide Cu, 0·74%; Sulphide Cu, 1·03%; Total Cu, 1·77%.

LEACHING TEST BY SULPHUR DIOXIDE PROCESS

Double Drum, with addition of 0·5% Fe as Ferrous Sulphate.
Feed at 40 mesh at rate of 2,000 grams per hour. Pulp Ratio 4 to 1.
Volume of air plus SO_2 gas, 30 litres per minute.
Ingoing Gas 5% SO_2. Outgoing Gas 2% SO_2. Gas Efficiency 60%.
Temperatures: Feed Pulp 26° C.; Tailing Pulp 39° C.; Ingoing Gas 175° C.
Iron in Discharge Solution: 0·05% Ferric Iron; 0·46% Ferrous Iron.

RESULTS BASED ON SAMPLES CUT FROM TAILING FLOW EVERY 30 MINUTES.

Sample Number	Discharge Solution Analysis. (per cent)		Tailing Analysis. (per cent)			Apparent Extraction. (per cent)		
	H_2SO_4	Ferric Iron	Copper Oxide	Copper Sulphide	Total	Copper Oxide	Copper Sulphide	Total
1	0·17		0·026	0·60		96·5	42·0	
2	0·15		0·026	0·66		96·5	36·0	
3	0·20	0·05	0·022	0·72		97·0	30·0	
4	0·17		0·022	0·68		97·0	34·0	
5	0·17		0·014	0·64		98·1	38·0	
6	0·18		0·014	0·62		98·1	40·0	
7	0·24	0·04	0·013	0·70		98·3	32·0	
8	0·27		0·013	0·66		98·3	36·0	
9	0·25		0·026	0·65		96·5	36·8	
10	[illegible]	0·06	0·026	0·67		96·5	35·2	
Average		0·05	0·02	0·66	[illegible]	97·3	36·0	61·0

Remarks.—Straight SO_2-leaching test, run for dissolution of non-sulphide copper only. Apparent extraction of non-sulphide copper 97·3% with 0·02% tails. Dissolution of 35·2% of sulphide copper content is wholly incidental.

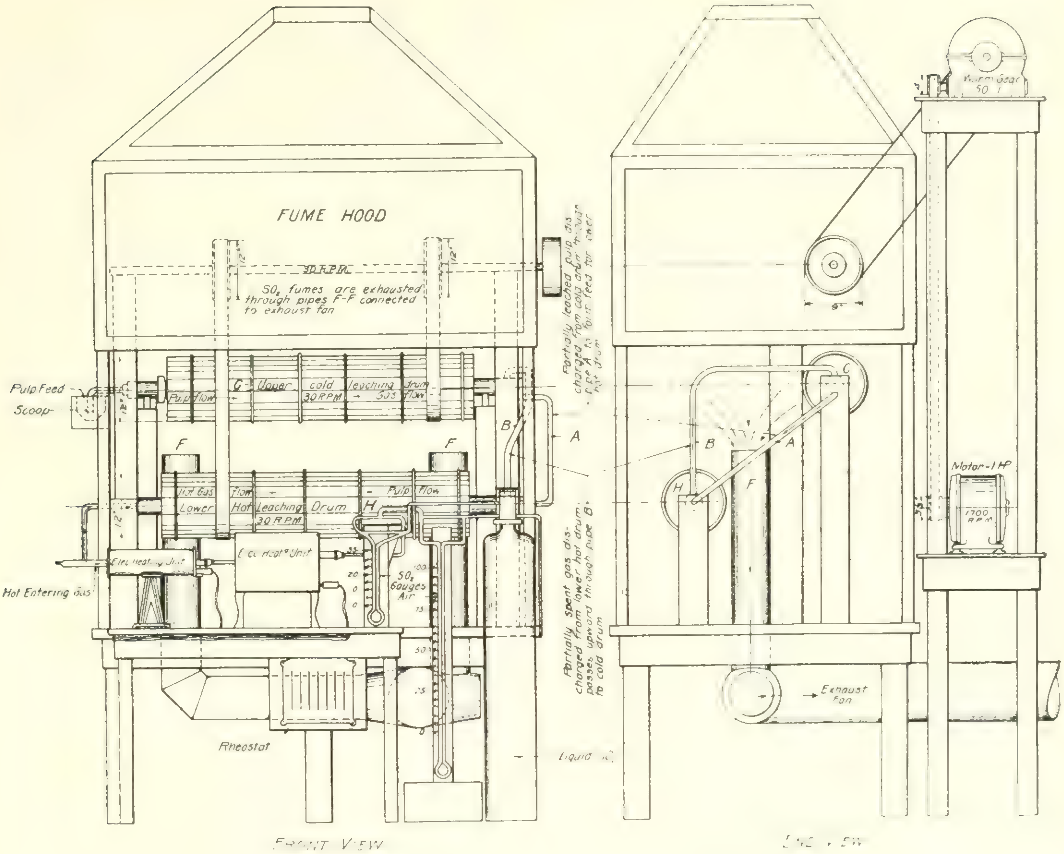


FIG. 2.—TUCSON PILOT DRUM.

TABLE I.—SUMMARY OF SO_2-LEACHING TESTS WITH ADDITIONS OF $FeSO_4$ IN PILOT DRUM ON REPRESENTATIVE ORES.

Name.	Pulp Analysis. Insoluble (1)	Fe_2O_3 and Al_2O_3. (2)	S (3)	CaO and MgO. (4)	Acid loss 100% H_2SO_4 lb. per ton (5)	Per Cent Copper. Drum Feed % Cu. Non-Sulphide. (6)	Drum Feed % Cu. Sulphide. (7)	Drum Tail % Cu. Non-Sulphide. (8)	Per cent Apparent Extraction Non-Sulphide. Cu. (9)
Miami Copper Co.	92·8	2·60	0·60	0·20	64	0·74	1·03	0·02	97·3
Inspiration C. Cop. Co.	93·7	2·62	0·75	0·75	118	1·14	0·20	0·075	93·5
New Cornelia Cop. Co.	85·4	7·74	2·90	Trace	178	1·27	0·59	0·08	94·0
Ray Cons. Cop. Co.:									
Concentrating Ore	85·0	6·80	2·80	0·20	49	0·52	1·28	0·04	92·0
Refractory Silicate Ore	70·4	16·00	0·20	0·50	206	1·27	0·62	0·07	94·5
Arizona Copper Co.:									
Shannon Old Tailing	79·0	10·40	0·80	1·20	150	0·60	0·64	0·05	91·3
Clifton Old Tailing	63·4	22·20	0·58	0·83	64	0·90	0·38	0·01	99·0
Morenci Old Tailing	66·0	18·96	0·72	0·54	83	0·58	0·32	0·03	94·8
Chino Copper Co., N. Mexico	85·8	8·15	1·0	0·50	137	1·42	1·15	0·09	93·7
Utah Copper Co.	85·4	6·40	3·9	0·20	54	[illegible]	1·63	0·08	86·0
Oxidized Capping	89·18	9·06	0·10	0·30	87	[illegible]	0·06	0·04	94·3
Silverbell, Arizona	43·47	33·50	2·63	1·04	23·4	4·45	1·87	0·38	91·5
Pinto Valley	81·70	4·82	0·12	0·80	210	5·29	0·39	0·18	96·6
Walker River Copper Co., Yerington, Nev.	78·60	7·40	0·20	0·30	170	[illegible]	0·12	0·077	96·6
Electrolytic Mine, Luning District, Nev.	55·21	15·77	Trace	3·00	627	2·36	0·43	0·26	89·0
Mayflower Mine, Luning District, Nev.	69·36	13·16	Trace	2·40	343	2·60	0·29	0·14	94·7
Pilot Copper Mine, Luning District, Nev.	43·8	17·53	0·75	0·67	250	5·11	1·51	0·25	[illegible]

is sulphuric-acid leaching. Considered with regard to recovery of total copper in wholly oxidized ores in which sulphide copper, if present at all, exists in negligible quantity, sulphuric-acid leaching has certain undeniable advantages. It is possible with comparatively coarse crushing, 3-mesh, to minimize percolation difficulties and with a relatively small volume of reagent to effect a good dissolution of copper and to recover from 60 to 80% of the dissolved copper by electrolysis, the remainder being recovered by precipitation on iron. The plant investment is high. The power-cost factor is most important. When the ore to be treated is mixed ore, requiring fine grinding to the point of liberation of the sulphides in any event, one distinct advantage of the sulphuric-acid leaching process is lost, and, on the other hand, a distinct advantage of SO_2-leaching in the drum is brought into full play. It is possible to pre-float sulphides and to obtain perfect contact between pulp and leaching reagent in the drum regardless of the quantity and fineness of slimes.

ADVANTAGE OF SO_2-LEACHING.—Summed up, the advantages are: That plant is compact and not expensive; there are no installation difficulties; power requirements are light. Operation of plant is simple and easily controlled; there are no delicate adjustments or critical points. Percolation difficulties common to leaching are entirely avoided. Perfect contact is assured between finest ore particles and the reagent. The reagent is very cheap and excellent utilization is attained; the process may therefore be extended to ores having a much higher acid-soluble gangue content than could be considered in ordinary sulphuric-acid leaching practice. The process is applicable alike to large operations and to relatively small operations without undue increase in operating cost for the smaller installations.

ACKNOWLEDGMENTS.—We fully appreciate the spirit of co-operation manifested by the officials of the copper mining companies throughout the South-West, especially the Miami Copper Co., at Miami, Arizona, and of the Arizona Copper Co., Ltd., at Clifton, Arizona. We are particularly indebted for assistance rendered in the development of the process by Mr. H. W. Morse, consulting metallurgist, H. D. Hunt, metallurgist, and R. V. Thurston, research engineer, of the Miami Copper Co.'s staff; by Arthur Crowfoot, general mill superintendent, of the Arizona Copper Co.'s staff, and Kenneth Donaldson, foreman of this company's Clifton experimental mill.

BOOK REVIEW

A Handbook of the Petroleum Industry.

By DAVID T. DAY, Ph.D., Editor-in-Chief. Two vols., large octavo, 1,970 pages, illustrated. Price £3 15s. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

In his preface Dr. Day states that this handbook is written for the public, but with especial reference to the engineers who produce and refine oil. With this keynote we concur; a handbook comprehending the whole of the petroleum industry must necessarily appeal first to the public, although why a general handbook should appeal only to the engineers who produce and refine oil and not to all engaged in the industry is not clear. We presume, however, that the emphasis is due to the fact that the present edition does cater more for these branches of the industry, and with a wealth of detail somewhat awe-inspiring to the general public. From the title we do not gather that it is essentially the *American* petroleum industry which we are to find presented for our study, but, needless to say, an American publication might well be pardoned for regarding the two as identical; while we need not look upon it as a drawback, since any other course at the present time would not be practicable, with the European fields and industry in the state they are. From the preface, too, we gather that the feature of the industry which most needs exposition is modern practice in refinery construction; the efforts of the authors in this direction merit great praise, they having succeeded in doing for modern American practice what Singer did for European some ten years ago. We venture to think that the subject of refinery engineering will be generally recognized as the best part of this work; it is closely followed in order of merit by those chapters dealing with the characteristics of petroleum, testing methods, internal combustion engines, the use of fuel oil and natural gas gasoline, while oilfield development and production, oil-shales, and lubrication are not far behind, as far as originality of treatment goes.

To review the book in detail, we find that

oilfield geology receives but relatively scanty treatment, the first two chapters, that on occurrence with 166 pages, which gives a good summarized account of the American fields, including recent bibliography, with brief and not always very correct descriptions of foreign fields, and the next which contains a short account of field methods of surveying in 34 pages, representing this side of the industry. The former of these two chapters contains, in addition to the description of the fields on a geographical basis, a classification of oilfield structures on the lines already familiar to readers of F. G. Clapp, The latter, which is the work of F. H. Lahee, gives the various methods in use for topographical and geological surveying as far as space permits. We feel, however, that such subjects do not lend themselves to one chapter in a general handbook.

We should equally welcome more space allotted in future editions to Mr. Sands for his thoughtful handling of field development and production. The subject of fishing is very well dealt with, a feature hitherto neglected, and great pains have been taken in making descriptions of drilling methods, etc., as lucid as possible for the lay reader, with, at the same time, much practical detail for the engineer. If there is a criticism that applies to the engineering sections of this work, it is regarding the reproduction of photographs, which are often not clear and might well be replaced by drawings, which are always to be preferred.

Transportation is interpreted mainly as pipe-line work, the part dealing with tankers being brief, while tank-cars come in for a little more consideration. Not only the theory of pipe-line flow as so ably developed by Professor Durand is given at length, but modern methods of computation, as well as of surveying and laying pipe-lines, are well illustrated by abundance of practical detail. The handling of viscous oils by pipe-lines first came seriously to the fore in California some twenty years ago, and this has resulted in a careful study of the problem and the elimination of the empiricism hitherto the mainstay of such calculations. Both oil and gas lines are here dealt with, and among the wealth of practical data given it is interesting to note that steam still holds sway as the motive power in spite of the greater fuel economy of the internal combustion engine.

The chapter for which Dr. Day takes credit gives us first a valuable and clear table of the various constituents of oil, their properties, etc., in which authorities are found in the last column, but all references and confusing details are skilfully avoided ; this is followed by tables of oil analyses from practically all known fields.

The subsequent chapter deals with testing methods as in current use in American refineries, which are given solely from the practical point of view and without historical or other matter which is of little use. This section will be welcomed not only by the student, but by all interested in handling of petroleum products and does great credit to its author, T. G. Delbridge.

The strides made in the natural gas gasoline industry during the past decade are known to most, at any rate from the point of view of yield, but it will come as a surprise to many to learn how the technical side has equally developed. In the chapter on this subject this is well brought out in the comparison of the compression and absorption methods and the practical data regarding the design of plants, notably as regards such matters as heat exchange, about which hitherto little information was available. The diagrams are clear and H. C. Cooper may be congratulated on his work.

Asphalt is dealt with from the side of setting and uses rather than its occurrence or mining. We miss, too, on this side of the Atlantic a detailed account of the asphaltic limestone industry. Similarly the section on oil-shales comprises an excellent compendium of American occurrences, and as such is to be welcomed ; but without European references this appears rather one-sided, and we do not see any account of the micro-study of such rocks which has been so productive of interest of recent years. The question of when a commercial development of oil-shale will take place in the United States is left open, although regarded as a certainty in the future.

Turning now to refining, we find that the engineering side has been most carefully handled, both in the matter of tables and of drawings ; all questions of design are quite the best set out we have seen. The only criticism we might make is that much of a general engineering nature is included that might well be left to the literature dealing with that branch and the space gained devoted more to the chemistry of refining. We should have liked to see agitation more fully gone into, very little, for instance, being said about mechanical as compared with air agitation.

As regards cracking, we have a useful résumé of the principles involved without much attention to details, and in place of a general discussion on the various uses of petroleum there are handy chapters on the subject of the use of fuel oils, on internal combustion petroleum engines, and on lubrication, the branches of the subject of especial interest nowadays. Thus the use of fuel oils is well illustrated by drawings of metallurgical and other heat-using plants, as well as the various steam-raising systems now in vogue, and in accordance with the general tenour of this work, the subject is well handled from the engineering point of view. Similar remarks apply to the chapter dealing with internal combustion engines, which after a clear and concise statement of the theory of the hot-surface type of motor and a description of the various cycles, well illustrated diagrammatically, deal with the general design and operation. This is followed by similar treatment of the Diesel, various types being described with considerable practical detail. Finally, a short account of the petrol engine brings the chapter to a close. The chapter on lubrication is excellent on the factors influencing the selection of a lubricant, and it is also provided with a good bibliography.

Pipe standards and the use of pipe are of interest to the oilman, particularly when from the pen of an expert like F. N. Speller, of the National Tube Company. The tables duplicate in part some already given under oilfield development, and again some among the general tables at the end of the book (pp. 782–4).

A fairly comprehensive glossary deserves commendation.

To summarize, these two volumes represent a deal of up-to-date information in handy form. That the bulk of this deals with the handling and uses of petroleum subsequent to its actual mining is no drawback; it is true there are some points we should like to see more fully dealt with, notably the commercial side, and generally more details as to costs in most departments. Other room for expansion might be found in the geology, the chemistry of refining, and the relation of the petroleum to the coal-tar industry, but such would entail a third volume at least. Since Dr. Day pleads that it is a first edition, let us hope later to see expansion on these lines. The practice of allotting each section to a specialist is good; it, moreover, should facilitate the splitting up into a number of separate volumes, which we feel to be the ideal form of publication for a general handbook of the petroleum industry.

T. G. Madgwick.

☞Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, London, E.C.2.

LETTERS TO THE EDITOR

Crystallization of Orthoclase

The Editor:

Sir—In his paper, "The Geochemical Functions of Water," Dr. J. Morrow Campbell makes the assertion that "orthoclase almost always crystallizes first, no matter which component is in excess," the other component being quartz. (See p. 213, sub-heading *b*, in the Magazine for April.)

Following others in arriving at this conclusion, he has based it no doubt on the idiomorphism of the one mineral to the other. Such evidence has been proved by modern research to be at variance with the true order of crystallization, and is construed nowadays as pointing merely to when the mineral showing the euhedral faces *ceased* crystallizing. Quartz and orthoclase may have begun to crystallize together; in fact, quartz may have been first, for the euhedral faces of the orthoclase only prove that its growth as a crystal ceased prior to that of the quartz. The subject is dealt with fully and concisely by Dr. Arthur Holmes in his work on "Petrographic Methods," to which I would refer Dr. Campbell and all others interested in the subject.

K. Murray Hughes.

Sable Antelope Mine,
Northern Rhodesia.
July 30.

Gold and Currency

The Editor:

Sir—I trust you will allow me further space in which to reply to the Editorial in your May issue on my letter *re* "Gold and Currency." The matter is one of urgent and world-wide importance, and action with regard to it is long overdue.

Your Editorial evidently misunderstands entirely my proposal. I do not seek to "create an artificial price for gold," unless such facts as an ounce of gold being, prior to 1914, worth 85s. and being worth \$20·67

constitute creating an artificial price. Was the act of deciding, not very long ago, that the sovereign should contain 123 grains of gold "creating an artificial price for gold?" The Act now advocated is precisely similar, but with a different number of grains to the sovereign.

I seek simply to re-establish the pre-war condition of currency, no more and no less, except that the pre-war parity between gold and paper be altered.

There is probably no thinking person who does not agree that the restoration of the interchangeability of paper and gold is desirable, and further that the divorcement of gold and paper has had and is having most injurious effects on industry. The only point that is open to difference is the manner of effecting the restoration.

There are only two that are worth discussing. One is by withdrawing the paper and deflating prices to the necessary extent. The other is what I advocate, namely, leaving the paper as it is, or has been for a suitable past period, and increasing the mint price of gold to the necessary degree.

The evils of the former method I have pointed out in repeated publications. There is nothing in the latter method that is difficult of achievement or that would do mischief.

I cannot understand your remark, "if gold is not to be sold by its value in the market-place we might as well go back to cowry shells, etc." Obviously the commodity that is the medium of exchange cannot vary in price. It is itself the standard by which all other commodities are measured. Gold varies in market price in those countries where it is not the standard, such as Britain, Italy, Germany, etc. It varies because the currencies, that is the standard measures of price, vary in value, though they remain fixed as to price. It does not vary in America, because there it is the standard. Before 1914 it did not vary in price in Britain, because it was then the standard there. That condition, long established and well proved to operate efficiently, we want to re-establish.

In view of the above it is perhaps superfluous for me to say that the idea does not "place the control with a Government department." I repeat, the aim is to simply restore the pre-war conditions, but with a different parity between paper and gold. As paper is to-day the legal tender of the country, this means putting a higher price on gold.

The idea is to put a new permanent price on gold, not to have the price adjustable. A new price has already been put on gold by our currency vagaries. The price, however, is variable. It has varied some 38s. within the past two or three years. The proposal is to decide on the proper price for gold, that is, to decide on the weight of gold to put into the sovereign. The proper price would be chosen with due regard to the rights of both creditors and debtors and to the need for avoiding mischief through change in price level.

H. R. Sleeman.

Whim Well, W.A.
July 8.

Concentration of Minerals by Alternate Electric Currents

The Editor:

Sir—I should like to make some remarks with reference to Mr. Mordey's paper, published in the June issue of the Magazine, on the Concentration of Minerals by Alternate Electric Currents. Having assisted in 1920 at the earlier practical tests mentioned on page 340, I am still of opinion that a more successful result would have been obtained by superimposing the magnet over a stream of pulp. In the experiment as mentioned, the magnet, placed under a tilted launder, was lifting hematite against gravity from the lower slower moving layer of water, and so some became entangled with the quartz in the eddying upper layer, thus going dead against the principles of natural water concentration. By superimposing the magnet over an ordinary launder it would appear that the concentrate would remain at the head of the launder and the quartz be swept away, for both gravity and natural concentration would be assisted and the mineral would behave as if it were as heavy as gold, while the jigging motion caused by the alternating current would release any sand entangled. The energy necessary should also be a fraction of that required to lift a mineral against gravity, my experience with direct current magnetic separators being that fines need more energy than large particles, not because thay are less magnetic, but because with fixed poles the fines have to jump a larger air gap than the coarse.

E. W. Byrde.

Jos, Nigeria.
August 4.

NEWS LETTERS

VANCOUVER, B.C.

August 10.

Drought and Forest Fires.—The prolonged drought, which in many parts of the province has continued for a longer period than ever before recorded, has had an injurious effect on the mining industry, not only by causing a shortage of water for power and ore-dressing purposes, but, in several instances, in removing the whole, or a large number, of the men from the mines to fight neighbouring forest fires. Despite this precaution, a number of the smaller mines in the Kootenays have lost all their surface equipment. The Gibson, Silver Bell, and Silver Bear, on the south fork of Kaslo Creek, and the Silver Cup and Big Tunnel, near Ferguson, in the Trout Lake district, lost all their surface buildings. The Gibson mine was sold by sheriff's sale on the day of the fire for $76,000, and the unfortunate purchaser did not hear of the conflagration until after the deal had been consummated. At one time a fire 120 miles in length was raging in the Babine region, to the north of the Grand Trunk Pacific Railway. The Tidewater Copper Company, which is operating at Sidney Inlet, Vancouver Island, by a plant run entirely by water-power, and which has been shipping between two and three hundred tons of a 38% copper concentrate for some time, has had to close its mill on account of water shortage. Development of the mine is being maintained, and production will be re-started as soon as water is available.

The Consolidated Mining and Smelting Company has lessened its production of lead and zinc slightly during the past month. Coal, rather than water, shortage has been the difficulty in this instance. The company has been getting its coke from the Crow's Nest Pass Coal Company, at Fernie, for several years, and this concern has been closed by a strike since April 1 of this year; consequently the smelting company has had to manage with the stock it had on hand at that date. Early in the summer, with a view to conserving fuel, the company curtailed production at its gold-copper mines at Rossland, and concentrated on the production of zinc and lead, which, besides being in greater demand, consume less fuel in their production. Recently the Consolidated Company has entered into a contract with the Canadian Collieries (Dunsmuir), Ltd., for a supply of coke, and the latter company has repaired and re-started its beehive coke-ovens at Comox, Vancouver Island, which have been idle for several years, so the Consolidated will have an ample supply of coke again now, though it is not as good a metallurgical coke as that made at Fernie.

Coal Mining on Vancouver Island.—It is an ill-wind that blows no one any good. The coal strike at the collieries in the Kootenays and in the United States and the railway shopmen's strike in the latter country, which has greatly retarded the transport of coal in the West, has given a great impetus to coal mining on Vancouver Island, and the industry, which had been languishing for a long time, because, owing to the high price of labour, it has been unable to compete with Californian fuel oil, is now in a better condition than at any time since the armistice.

The Premier Gold Mining Company, which derives its water for power purposes from a stream supplied by melting glaciers, has not suffered from a shortage of water, and it has been able to maintain, and, in fact, rather increase, its shipments. During the first six months of the year the company shipped more than 40,000 tons of ore over its new tramway, and present indications point to a larger shipment being made in the second half of the year.

Big Missouri.—A. B. Trites' good fortune seems to remain with him. He was one of the original syndicate that developed the Premier and brought it to the producing stage, and he still owns a one-tenth interest in the company, besides having received a large cash consideration for the interest he sold to New York capitalists. As reported last month, he and associates took an option on the Big Missouri, about 4 miles higher up the Salmon River than the Premier, and after a couple of weeks' exploration a 14 ft. shoot of high-grade ore has been found and traced for 200 ft. on the surface. At the time of writing the shoot had not been thoroughly sampled, but it is described as high-grade shipping ore, which means in this locality that it runs probably over $70 per ton.

The Esperanza mine, near the town of Alice Arm, has been sold to an Anyox syndicate for $35,000. The former owners of the mine have been shipping a medium-grade silver ore to the Granby smelter for some time, and recently two new ore-shoots

were found in a tunnel above the main workings.

GRANBY CONSOLIDATED.—J. A. Bancroft, formerly professor of geology at McGill University, and for the past year assistant manager for the Granby Consolidated Mining, Smelting and Power Company, has resigned his position, and will return to his former post at McGill. When Dr. Bancroft was appointed by the Granby company, after having spent several summer vacations in studying the Hidden Creek ore deposits for the company, the directors of McGill gave him a year's leave of absence, in which to decide whether he preferred the practical work at the mine and smelter to pure science at the University. He has chosen in favour of the latter. Dr. Bancroft will be missed by mining men in British Columbia, where he has taken an active part in the Institute meetings, and he will be missed especially at Anyox, where last winter he established classes in mining geology for the benefit of the more ambitious workmen at the Granby company's mines. L. R. Clapp, who has had a wide experience in copper mining in the United States, has been appointed assistant manager for the Granby company.

THE KOOTENAYS.—Conditions in the Kootenays are showing a marked improvement. The Silversmith Mines, Ltd., which has been shipping lead and zinc concentrates and high-grade lead ore to three different smelters, declared a dividend of $25,000 for the quarter ended June 30. This is the first dividend that has been paid since December, 1920, when a similar amount was disbursed. The company is said to have developed sufficient ore to maintain the present rate of production for two or three years. The Florence Silver Mining Company is operating its mine at Ainsworth once again, having replaced the tributers who have been working parts of the mine for the last eighteen months. Ore at the Florence occurs both as fissure and replacement veins, some of the latter making immense ore-bodies. It is said that there is ample ore in sight to keep the 300 ton mill running at capacity for three years. A good deal of zinc concentrate is being shipped from the Standard mine at Silverton, which changed hands about a year ago. This, however, is material that was mined by the old company and dumped at a time when zinc had no value. It now is being treated at Trail under the new schedule, and is returning a good profit to the shippers. The Standard Silver-Lead Mining Company, former owners of the Standard mine, has bonded the Ivy Fern group, on Cultus Creek, Kootenay Lake, and has taken an option on a large block of the stock of the Slocan Silver Mines, Ltd., which owns andoperates the McAllister mine at Carpenter Creek, and the Standard is doing extensive development at both properties. The Standard has $400,000 in the treasury, and for the past two years has been searching the Kootenays for a suitable mine in which to invest its capital. Good strikes are reported from the Comstock and Whitewater on Cascade Creek; the Bullock on Poplar Creek; and the Miner's Boy at New Denver. Clarence Cunningham, one of the principal operators in the Slocan, has re-started the Alamo mill on ore from the Wonderful mine. The annual report of the Nugget Gold Mines, Ltd., for 1921, shows a production valued at $74,000, and an operating loss of $9,000.

TORONTO

August 12.

NEW RECORD OF GOLD PRODUCTION.—A new high record of production by the gold mines of Northern Ontario was established during July, when, according to preliminary estimates, the aggregate output of gold was approximately $1,755,000. Eight mills were in operation, three in the Porcupine field and five at Kirkland Lake, all with the exception of two working at full capacity, and handling a total amount of 175,000 tons of ore. The increase in production has been steady, and promises to be continuous, as most of the present producing companies are planning to enlarge their mills, and other enterprises in process of development are likely shortly to enter upon the production stage.

PORCUPINE.—An official announcement has been made to the effect that the dividend rate of the Hollinger Consolidated will be increased in the near future. Negotiations with the Government respecting hydro-electric power are stated to have reached a stage which will enable the company to proceed immediately with the development of power adequate to its needs. This will require about a year, and will enable the company to double its output and become the largest gold-producing mine in the world. The Hollinger has exercised its option on the adjoining Schumacher property

and has made the initial payments of a total purchase price of $1,650,000.

The Dome Mines during July produced gold to the amount of $335,754, from the treatment of 31,900 tons of ore, being a recovery of $10·55 per ton. The total production for the seven months ended July 31 was approximately $2,280,000.

Rich ore has been encountered on the Davidson Consolidated. At the 874 ft. level gold content for 15 ft. ranged from $7·40 to $20·40 per ton, the next foot showing $126·70, followed by low grade. An ore-body struck in diamond-drilling on the 1,235 ft. level also showed good gold content.

The Vipond Consolidated, which is a merger of the Vipond and North Thompson, has accepted an offer of A. E. Moysey to purchase 333,333 shares at 40 c. per share, with the option of taking the remaining 666,667 shares of treasury stock at the same figure. This places the company in a financial position to carry out an extensive plan of development.

The McIntyre has purchased the Schumacher Veteran claim, adjoining the Dome Mines for $400,000, and is planning extensive development. The Newray is being explored at depth by diamond-drilling. The drills will be put down for one-third of a mile to determine the position of the intruding porphyry formation. Good ore has been found on the Goldale at a depth of 240 ft. and it has been ascertained that gold content is distributed through the schist in a similar manner to that characteristic of the McIntyre. High-grade ore has been encountered on the Holtyrex at 375 ft. The vein is believed to be a continuation of one of the Hollinger deposits.

Kirkland Lake.—The balance-sheet of the Lake Shore for the half-year ended May 31 shows profits of $169,167, as compared with profits of $51,723 for the entire preceding year. Cash on hand amounted to $315,890. The recovery of gold during June was $52,539, being an average of $31·73 per ton treated. Reserves above the 600 ft. level were estimated at $10,000,000. The plans for further development include the enlargement of the shaft, sinking to the 800 ft. level, and the installation of more air capacity in preparation for an increase in the milling equipment.

During July the Wright-Hargreaves produced nearly $80,000, the output being the second highest recorded. Two important veins are being developed at the 700 ft. level, and a large ore reserve is gradually being accumulated.

The Teck Hughes also largely increased its production during July. Ore extracted from the 730 ft. level yielded upwards of $25 for each ton treated. The shaft is being put down to a depth of 1,000 ft.

At the Tough Oakes the first clean-up from the mill in June produced about $19,000. A second clean-up last month realized approximately $12,000. The high-grade occurrences are stated to be erratic, rendering it difficult to obtain uniform milling results.

Good headway is being made in sinking the shaft on the Bidgood from the 400 ft. to the 600 ft. level. When the work is completed a cross-cut will be run to tap the downward continuation of the vein. The Nipissing of Cobalt has received an option on a claim at the west end of Gull Lake adjoining the Kirkland Lake Proprietary. Kirkland Gateway, a new company, has taken over the properties of the Marigold and Green-Kirkland companies, with a total area of approximately 800 acres, and will put the shaft down to 400 ft. and explore the property by diamond-drilling. The King Kirkland has a shaft down 170 ft., which will be continued to the 500 ft. level. The Kitchener Kirkland has put down a number of test pits with satisfactory results, and will undertake diamond-drilling preparatory to development work.

Cobalt.—The Nipissing during July produced approximately 275,000 oz. of silver of the value of $191,138. Vein No. 251 has developed into one of the most important discoveries in the camp of recent years, and is expected to yield two to three million ounces. Another recent discovery is yielding well. Diamond-drilling operations by the Coniagas on the Ruby property under option indicate a broadening of the mineralized area, as the conglomerate formation, which is the source of most of the silver produced, has been proved to have a thickness of 250 ft. At the Colonial a shaft is being sunk to the 900 ft. level, where lateral operations will be carried on at the diabase-Keewatin contact. The Nipissing and the Mining Corporation have latterly been shipping out several cars of residue each week to Ontario smelters. The silver content of the residue runs from 50 to 100 oz. per ton, and the cobalt content will about pay shipping and treatment charges.

South Lorrain.—The Mining Corporation of Canada, which is operating the Haileybury Frontier and Crompton properties under option, is taking out some rich ore, running from 4,000 to 5,000 oz. to the ton, from a vein 13 in. wide. Production has so far amounted to about 250,000 oz. About ninety men are employed.

MELBOURNE

July 6.

Broken Hill Health Conditions.—The long-awaited final report of the Barrier Technical Commission, which consists of Professor H. G. Chapman and Dr. S. A. Smith, was published last week, and as a result the hope is cherished that the industrial position at Broken Hill will be materially relieved. The commission says that in all 6,538 mine workers were examined. They found that a condition of pneumoconiosis may arise in the lungs of mine workers as a result of the inhalation of particles of dust, but that this form of pneumoconiosis at Broken Hill differs from that which exists among miners at Bendigo, Cobar, and Kalgoorlie, and among rock-choppers in Hawkesbury sandstone. The disease was found almost entirely in men engaged in rock-drilling.

Pneumoconiosis is classed in two stages. In the first stage there is no impairment to general health, and less affection of the lungs than in the second stage, while the capacity for work is not lessened. In the second stage clinical signs may be found, and there may be some impairment of general health and capacity for work. These conditions render the miner more liable to contract pulmonary tuberculosis, which may supervene in either the first or second stage of pneumoconiosis. After infection with tuberculosis general health fails, and working capacity is impaired. Tuberculosis of the lungs may be found apart from pneumoconiosis.

Of the 6,538 mine workers examined, the commission discovered 373 affected with pneumoconiosis and tuberculosis in various degrees. Out of 2,618 practical miners (as distinguished from mine-workers) examined, it was found that 1,595 had worked as miners at Broken Hill only, while 1,023 had worked at Broken Hill and elsewhere. Of the 1,595 Broken Hill men 88, or 5·5%, were affected with pneumoconiosis, while of the 1,023 men who had worked at Broken Hill and elsewhere 166, or 16·2%, were so affected. Of the 373 men affected, 113 were classed in the first stage and 51 in the second stage of pneumoconiosis, while 102 had that disease complicated with pulmonary tuberculosis, and 107 had uncomplicated pulmonary tuberculosis.

The commission found that of 59 persons affected with pneumoconiosis complicated with tuberculosis before June, 1920, 20, or 33·9%, had died, 45·8% had become worse, while of 65 men then affected with tuberculosis 7, or 10·8%, had died, and 38·4% had become worse. It was found that 18 persons previously affected with pneumoconiosis who had remained in Broken Hill had contracted pulmonary tuberculosis, while only one who had left the district and the mining industry had become so affected.

A complete examination for lead poisoning was carried on in respect of 6,538 persons. Of that number, 61, or 0·9%, men were found to be suffering from the effects of lead poisoning. Of these men 27 had worked underground only. Sixty-one persons gave a history of having suffered from the effects of lead, and presented evidence, on medical examination, of injury to their health. The commission recommends that these men should be excluded from the industry and compensated. The commission concludes that men working in or about the Broken Hill mines are without exception exposed to the action of lead circulating in the blood. Chemical analysis of the dust present during various operations in the mines and the minute quantity of lead found in the urine, lungs, and kidneys, showed that the concentration of lead in the blood to which workers in and about the mines at Broken Hill are exposed is low. Of 823 general labourers who had worked only on the surface, five were found to be suffering from lead poisoning, and 774 mill hands who had worked only on the surface, one who had worked for twenty-six years was affected.

The commission is of opinion that the effect of the poisoning due to lead in this industry should be prevented by removing susceptible persons from exposure to the action of lead, and it recommends that poisoning by lead in the county of Yancowinna be made a disease notifiable to a medical authority. Further, that it be made necessary for all persons affected with or suspecting themselves to be affected with lead poisoning to report themselves to the medical authority and submit to examination. It is

suggested that a board of three medical practitioners, representative of the workers, the mine-owners, and the Government, be appointed as a medical authority to determine whether a person affected by lead shall remain in the industry or be excluded.

The definite opinion is expressed "that the amount of dust present in the air of the mines is so reduced that the quantity of dust taken into the lungs is no longer sufficient to give rise to pneumoconiosis, provided that the operation of mining is conducted in such a manner (1) that the firing of explosives takes place at the end of shift; (2) that a water blast is used after firing explosives, except in an open stope with an air current moving through it with a speed of 20 ft. a minute or more, and in a square-set stope with through ventilation; (3) that intervals of 30 minutes elapse after firing before continuous work is resumed in a working place; and (4) that the boring of holes with drills is undertaken under the precaution covered by general rule 55 of the Mines Inspection Act.

The commission is of opinion that if sufficient care is used boring is practically free from dust. The commission is satisfied from its test that mining in dead-end stopes, open stopes, and square-set stopes can be carried out without danger to mine-workers from pneumoconiosis if conducted in the manner indicated. The general system of ventilation operating in the mines examined during the 12 months in which those mines were at work, and during which the commission was making its observation, is satisfactory. It was found that gases generated by the use of explosives circulate with the air currents, but they found no evidence of any injury to health among underground workers produced by such fumes. The importance of free ventilation is emphasized. Finally, the commission recommends that systematic sampling of the dust conditions of various working places be continued, and that records be kept of the results of these tests, together with readings of the temperature, humidity, and cooling power of the air. In conclusion, the report states: "From these records it will be possible to obtain information as a result of which variations and improvements in the working conditions may be introduced at the discretion of the mining inspector or other official placed in control of mining conditions."

Considerable doubt exists as to the effect of the report on the Edmunds award. The matter, however, is explained in the clauses of the award governing working hours with reference to the commission's operations.

When the tribunal sat again in Sydney on October 27, 1920, to hear the decision of Mr. Justice Edmunds on several points in the award submitted to him for interpretation, Mr. Justice Edmunds ruled:—

"The companies could apply to reopen the award upon completion of the whole or part of the work of the Technical Commission, and their report thereon."

Consequently, if the companies wish to get the present working conditions altered, they must: (1) Withdraw and compensate the incapacitated men; (2) resume work, and carry the commission's recommendations into effect; (3) apply to reopen the award.

SOUTH AFRICA

August 8.

MINING STAGNATION.—The mineral production of the Union for the half-year to June 30, 1922, is declared by the Mines Department at a poor figure under all heads. Gold and associated silver (£11,482,000) are low on account of the strike, and coal ($4\frac{1}{2}$ million tons, valued at £1,700,000) is down owing to the strike and trade depression. The other mineral products show disappointing returns without internal difficulties to explain weakness. Diamond production, chiefly from the Premier mine and alluvial diggings, totals less than £1,000,000. Tin and copper average £5,500 per month combined, a pathetic commentary on our promises of base-metal development. Copper mining will be stimulated by the resumption of work at the Messina mine, under the influence of the Government subsidy and alleviation of Government mining regulations.

TRADES UNIONS AND A CONCILIATION BOARD.—Until the Rand has set its house in order and industrial confidence has been restored, we can look for little new enterprise in the gold districts or in other fields. Nearly all new ventures are inspired from Johannesburg, and, at present, this centre is thoroughly depressed, with little enthusiasm for new speculations. There is no doubt but that a definite settlement as to the relations between the mining companies and their employees will stabilize the situation. Several of the men's unions have accepted the Chamber's conditions of recognition, but others still refuse to submit.

A committee formed by the unions has put forward proposals to cover future policy. Being one of the first lucid, constructive, and dispassionate schemes originating from this source, it merits a more than usual attention.

The proposal opens with the admission that "employers have the right to manage their respective mines and industries"; an important concession, weakened by the claim that "trades unions have the right to exercise the functions of trades unions and that through such persons as they deem fit to appoint." (The Chamber of Mines has placed a ban on certain extremists.)

A conciliation board is proposed after a dispute has passed the following stages: (1) Between workmen and departmental head, (2) between workmen, with union representative, and manager; (3) between union and directors or Chamber of Mines.

The conciliation board, for all gold, coal, and power disputes, to comprise four employers' representatives and four union representatives, with an independent chairman, and to be supported by the State. The board to sit in public and take evidence on oath if necessary. Agreements to hold for 12 months, and subsequently subject to three months' notice of termination on either side.

Where any alteration in the recognized working conditions is contemplated by the employers or workmen, such alterations shall not take effect until one calendar month's notice has expired, to give an opportunity for discussion.

Until any or all disputes between employers and employees have been carried through the procedure laid down, and a report received from the conciliation board, no stoppage of work is to take place, and no disputed alteration take place, providing the board reports within 14 days.

Broadly speaking, the document is commendable in that it confines settlements of disputes to the unions directly concerned, eliminating the influence of a political "Federation," which will only be seen again when there is sufficient strength and unrest and plunder to favour its resurrection.

LIFE OF THE RAND — The statistics covering the ore reserves or ore probabilities of the Rand, submitted by the Chamber of Mines to the Industry Board, provide a further basis for speculative estimates of the Rand's life. Briefly, the analysis shows the following aggregates of tonnage, payable under conditions to be readily foreseen when low costs are essential to existence.

	Tons.
(1) Producing mines	695,000,000
(2) Old producers, closed down	60,000,000
(3) Partly developed, with unattractive results.	60,000,000
(4) Undeveloped areas....	225,000,000
Total tonnage	1,040,000,000

This aggregate, representing 50 years at a high rate of production, may be translated into 70 years of activity, with normal vicissitudes and a languishing end. In other words, the estimate gives the Rand a vigorous life of a century from the date of discovery.

Extensions of the goldfield to the south-west are probable, but the great mines of the Rand, when once exhausted to the degree indicated by these estimates, will stand no chance of revival under conditions at present conceivable.

RAND GOLD REFINERY.—After many years of proposal and deliberation, the Rand now possesses a well-equipped refinery, capable of handling a ton of gold per day. The two primary functions of the Rand Refinery, Ltd., will be the production of refined gold and refined silver, this latter metal comprising 15% by weight of Rand bullion. The site chosen has been at India Junction, Germiston, reflecting the move of the industrial centre of gravity 10 miles to the east from its original position in Johannesburg.

PRESENT RAND WAGES.—The new schedule of wages adopted by the Chamber of Mines has been reported previously. An interesting sequel is the Government analysis of average pay received. Miners stoping averaged 22s. per shift and machine developers on contract 36s. 10s. per shift, indicating that development is still, quite rightly, being well-rewarded on an efficiency basis. Tradesmen generally average 22s. per shift, and white men on tramming, rock-walling, skip work, etc., 17s. 6d. per shift. The cost of living should fall to a pre-war figure in Johannesburg (where it was high) as soon as in any mining field in the world.

LUIPAARDSVLEI ESTATE PROFIT-SHARING SCHEME.—The "profit-sharing" scheme introduced by the directors of the Luipaardsvlei Estate, after the strike, does not conform to the best ideas of rewarding efficiency in mining, but it has had the effect of enabling this mine, in the luckless Krugersdorp area, to carry on in good hopes of

turning a corner. Last year's working costs led to inevitable losses in this 4½ dwt. mine. Working costs have now been dropped to below 20s. per ton, with normal yield, and the prospects of future improvement are good. The "profit-sharing" offered only amounts to a division of such profit (after £850 per month is earned for debenture charges and £1,000 per month for company's working profit), as will bring the workers' earnings up to standard wages. Such an arrangement may be satisfactory when there are many skilled men out of work or where there are men with neighbouring residences, prepared to sacrifice something for the advantage of local work. The lesson of the experiment, however, will not be far reaching. It is too well established that the best inducement for higher efficiency lies in prompt rewards for simply estimated improvements, within the scope of the individual efforts. The essence of the improvement will always lie in the mine itself, where the fathomage stoped or the footage advanced in development or the tonnage trammed, represent the best units as a basis for reward. Increases of pay based on monthly book-keeping, with the complication of indirect and non-productive charges, represent an unsatisfactory blending of technical and financial control, and is not, in the long run, a sound method of interesting employees, except officials, in the success of their efforts.

Mosesberg Diamonds.—The rush to the new Mosesberg diamond area, mentioned two months ago, has terminated in a sequel of hardship and disappointment; generally claim holders have failed to pay the expenses of the rush apart from the cost of their subsequent operations and living.

Underground Officials and a Five-day Week.—The attitude adopted by the underground officials upon the Rand during the strike was so exemplary as to raise this body of men above any suspicion of self-seeking, through their union or association, at the expense of genuine industrial welfare. Formed at a time when the demands of the workmen's unions were being conceded with suicidal liberality and the rights of the individual, outside these organizations, apt to be disregarded, the Underground Officials' Association was forced into existence against the better instincts of many who became passive members, fearing a policy of aggression and interference with liberty on trade union lines. In practice, the Association has fulfilled a good purpose and has frequently been the means of expressing enlightened opinions on technical questions liable to political twisting.

It is particularly disappointing, therefore, to find this Association advocating a five-day week on any other grounds than economy of wages where full-time cannot be profitably offered. Their scheme is the introduction of five shifts of 9½ hours in place of the usual six shifts of 8 hours. Not many years ago 9½ hours per shift was general. Evolution under the influence of calls for health, safety, and efficiency brought us to the 8-hour day. The soundness of the reduction has become so well established for underground work that discussion has practically ceased. That the miners could break the same fathomage and footage in five long shifts as in six (with the extra period for ventilation and the extra hours of morning vigour) is unthinkable. If they would break less, the scheme is retrograde. This is not the policy needed to revive the industry to-day.

CUMBERLAND

September 5.

Lead Mining.—The position of the non-ferrous mines in Cumberland cannot be considered very bright, as out of the mines working before the war only two have survived, namely, Greenside and Threlkeld, and both these are practically lead mines. Greenside has had a fine history, and although it has recently been in liquidation, the shareholders have reconsidered the position on the grounds that the price of galena has much improved, the royalties have been enormously reduced, and the mine is showing better ore. This company should weather the storm, and it is possible that it may have a fairly long life.

At Threlkeld mine the output is principally galena, and the deeper workings have shown a noticeably increased silver content; at the present time 10 oz. per ton of galena is obtained against a previous average of 6½ oz., an improvement in value of approximately 10s. per ton of ore. Since Mr. Eastwood's Memoir was compiled, a large amount of development has been carried out, and access to the new ground has been established in the Horse and Smithy Levels. The new bearing area already proved in the Horse or main adit level is well over 100 fathoms, and the lode is up to the average in the fore-breast. Above this main adit there is a back of 1,700 ft., and there seems but little doubt that the new bearing area will be workable

up to within a reasonable distance of the surface. The deposit has been proved in two places by means of rises to a height of 130 ft., and the history of the old mine shows unmistakably that the richest deposits were near the surface. This mine will be unique in this country as the workings get higher. It will be impossible to insist on men climbing hundreds of feet to the stopes, and while it is easy to run the crude ore down to the adit level by means of mills, a large amount of timber will be required for the intermediate levels. It is now proposed to construct several large mills, lined with concrete, which will be carried right up through the stoping ground, but as the sides of the lode are unsafe and the hade irregular, the mills will be cut deeply into the foot-wall, and as far as possible will be given an even slope. A large rise will also be carried through, exactly on the lines of an inclined shaft, but without a pumping compartment, and will contain a good climbing way and a double cage, actuated by an electric motor driven, of course, from the bottom. The detailed design is now being considered, and will require a good deal of thought, as the deposits are not vertical, and vertical rises or shafts have to cross, diagonally, wide areas in the lode, in which there is no sound ground for a width of say 20 ft.

The vein is very easily worked, the principal work being that of filling up, it being impossible to take the stopes more than 6 ft. high at a time. The whole equipment at the surface is being overhauled, and this mine should have a life of many years. Electric locomotives are to be installed within a few months, and the gas engine for the dynamo is already erected.

As far as galena is concerned, these two mines complete the immediate prospects of the district, the remaining possibilities depending entirely on the position of the market for zinc ores. If this were favourable Thornthwaite mines might restart, but the cost of clearing the mine would be heavy ; the water has risen 200 ft., and mining engineers are only too familiar with the cost of this operation. All the plants and pumps have been left in the mine, including rails and a complete system of compressed-air pipes, and up to the present the plant is intact.

CALDBECK.—There is a great future in the Caldbeck Area, especially for blende and barytes, but so far very little has been done. The chief necessity here is a railway, and this has been proposed and considered many times in the past forty years. The prospects, are, however, more favourable now, as an important group of quarry owners are taking up the granite deposits near the Carrock tungsten mine. If the preliminary tests are satisfactory, they will be able to offer 50,000 to 60,000 tons of traffic per annum. There are several blende-barytes propositions in the district, and chemists are now engaged on an investigation as to the possibility of using this mixed concentrate for the manufacture of lithopone. If there were a sale for this mixed product, two good mines would be available.

RUSSIA

METALLURGICAL CONDITIONS.—What is now taking place in Russian mining and metallurgical industries may rather be called complete stagnation than work. In 1921 the output of iron ore in the whole of Russia amounted to only 139,000 tons, whereas in the years immediately preceding the war the yearly output was 8 to 10 million tons. The production of cast iron in 1921 was 116,000 tons, while in 1913 it was 4,300,000 tons, 38 times greater than it is now. During the first months of the current year the amount of iron ore mined increased somewhat and reached 3% of the pre-revolutionary amount, but it began to decrease again in April. The amount of other ores raised is also exceedingly small. Thus, for instance, the output of manganese ore is less than one-fiftieth of what it was in normal times. Notwithstanding this insignificance of output, the Bolsheviks are unable to manage the mining industry, and it has been decided to cut down the output by one-third (see *Ekonomicheskaia Zhizn* for June 3, 1922).

During the first four months of the current year there were 14 blast-furnaces and 23 Martin furnaces at work in the whole of Russia, whereas normally there used to be about 180 blast-furnaces and 170 Martin furnaces working. During these months the output of cast iron, as compared with the last year, was slightly larger, being 57,000 tons, or about 4% of the normal production ; this increase falls exclusively to the share of the South Russian metallurgical industry. The metallurgical industry of South Russia, in pre-war days occupied a place of ever-increasing importance in the industrial life of the Empire. In 1913 it gave about 3 million tons of cast iron, being 67% of the total output of cast iron in Russia for that

year. In 1921 the output of cast iron in the South was less than 1% of that in 1913. In the first four months of the current year the South gave 18,000 tons, or 1·8% of the output of 1913. It is true that this was a certain increase as compared with the preceding year, but only an increase of an infinitesimally small quantity. Instead of 53 there are only two blast-furnaces now working in the South (see *Ekonomicheskaia Zhizn* for July 21), and moreover they work only at intervals. During the first four months of this year, when the work was considered to be going on very successfully, not even one-third of the amount projected was attained, and that, in its turn, was only 6% of the normal output. All attempts to set one or two more furnaces working were unsuccessful.

Other difficulties have arisen of late which may have very important consequences. The Soviet Government has transferred the majority of the nationalized undertakings to a so-called commercial basis. This means that they must be run on the money received from the sale of their produce. The expenses of nationalized industry are exceedingly great, as the intensity of its working is 3 to 4 times less than it used to be. The undertakings, therefore, have to fix very high selling prices. The brief experience of many other branches of industry (textiles, sugar, porcelain) has already shown that at such a level of prices there are no purchasers in Russia. This crisis of over-production, as the Bolsheviks call it, or rather this crisis in selling, has not yet been experienced in the metallurgical industry. But there is no doubt that under the economic conditions existing in Russia, where there is no freedom for private enterprise, this crisis will, in the near future, affect the production of cast iron. The metal and machinery works are still taking cast iron. But they are themselves beginning to experience great difficulties in selling their produce, and are partially diminishing their output, small as it now is. Thus it appears that even the present insignificant output of cast iron may become too great for the population of Russia. In other words, the population which formerly used to consume about 70 pounds of cast iron per head per annum is now unable to consume even 2 pounds. Of course, such a situation is altogether abnormal. But it can be altered only when everyone enjoys complete economic freedom, when all Soviet regulations and prohibitions are annihilated, and the inviolability of private labour and property is restored.

PERSONAL

F. O'D. Bourke is leaving next week for Northern Nigeria.

H. Kenyon Burch is designing a concentrating plant for the New Cornelia Copper Co., Ajo, Arizona.

G. W. Campion has left for West Africa.

G. P. Chaplin has left for Burma.

Cecil W. Dannatt is back from Trinidad.

Allan Davidson is home from Nigeria.

Professor J. W. Gregory has arrived in Yunnan, with the object of conducting scientific exploration in the mountains of south-west China.

R. L. Hewston has left for South Africa.

G. J. Inder has returned from Colombia.

Norman Jenks has returned from Spain.

C. E. Jobling is home from West Africa.

H. W. Laws, of Laws, Rumbold, & Co., has returned from eastern Siberia.

C. J. London is here from Colombia.

D. J. MacDonald has left for West Africa.

E. T. McCarthy has moved his office to Finsbury Pavement House, London, E.C.2.

J. Q. Mitchell has left for West Africa.

Arthur E. Page has returned from West Africa.

T. Pryor has returned to the Kolar goldfield, South India.

Harold Roberts has left for West Africa.

C. E. Rogers has left for the Rand.

R. W. Scott, manager for the Nigerian Tin Corporation, has left for Northern Nigeria.

J. Shea has returned from Argentina.

Ernest A. Smith has resigned as secretary to the British Non-Ferrous Metals Research Association, and has been appointed research metallurgist to the Sheffield Smelting Co., Ltd.

G. A. Stockfeld has left for West Africa.

A. T. Watson has left for West Africa.

Ernest Williams has returned from West Australia.

Horace V. Winchell is here from the United States.

Dr. G. A. Young has commenced an investigation of the iron-ore deposits of British Columbia.

Hans S. Meyer died in July at Johannesburg. He was born in London of a Danish family, and he took the A.R.S.M. and De la Beche medal in 1897. He went to South Africa in 1902 as a member of the technical staff of the Central Mining - Rand Mines group. In 1918–19 he was president of the Chemical, Metallurgical, and Mining Society of South Africa.

Gardner F. Williams died at Los Angeles, California, last month, at the age of 81. His great work was the development of the De Beers diamond mines, and his book on the subject is the best monument to his career. On the other hand he was not enthusiastic about the discoveries of gold on the Rand, and he kept Cecil Rhodes out of early participation.

C. B. Saner died early in July at Port Elizabeth, South Africa, in his 50th year. He was successively manager for the Transvaal Gold Mining Estates and Luipaards Vlei companies, and he sunk the Turf shaft at Village Deep. He served as president of the Chemical, Metallurgical, and Mining Society of South Africa for the year 1911–12. In 1917 he retired from mining and took up farming.

TRADE PARAGRAPHS

THE SULLIVAN MACHINERY CO., of Chicago (London Office: Salisbury House), have issued a bulletin, No. 69 O, dealing with diamond-drilling for oil.

THE ALDEN ENGINE CO., LTD., of the Crown Works, Oxford, have issued a new folder describing their electric lighting sets for houses, etc., driven by paraffin motors.

NOBEL INDUSTRIES, LTD., of Nobel House, Buckingham Gate, London, S.W. 1, have issued an illustrated booklet in English and Portuguese for distribution at the Brazilian Centenary Exhibition at Rio de Janeiro, which was opened on September 7.

PRIESTMAN BROTHERS, LTD., of the Holderness Foundry, Hull, send us their list No. 195 dealing with their grabs and steam shovels, which have a large application in iron-ore mining. The firm's London office has been removed to 28, Victoria Street, S.W. 1.

THE HARDINGE COMPANY, of 120, Broadway, New York, and 11-13, Southampton Row, London, W.C. 1, have issued a pamphlet giving a useful outline of the work done by their conical mill and its many applications to wet and dry grinding, granular or fine.

T. COOKE & SONS, LTD., of 3, Broadway, Westminster, and Buckingham Works, York, send us their price list of surveying instruments, etc., to be used in association with their catalogue and manual of these instruments which was noticed in a recent issue of the MAGAZINE.

VICKERS, LTD., of Vickers House, Westminster, have received an order from Sir Ganga Ram for water turbines and electrical plant to be used for the development of power from a fall on the Bari Doab Canal in the Punjab. The head of the water to be employed is only 6 ft., so the scheme is one of special interest.

THE CONSOLIDATED PNEUMATIC TOOL CO., LTD., of 170, Piccadilly, London, W.1, have been appointed sole selling agents for the British Empire and the Continent of Europe for the DUFF MANUFACTURING CO., makers of the well-known Duff Genuine Barrett & Duff lifting jacks and of the Duff Dunn patent trench braces.

THOS. FIRTH & SONS, LTD., of Sheffield, have published a book of 85 pages dealing with Stainless Steel, its development, properties, and uses. The information has been collected in the firm's research laboratories, and will prove very helpful to all in search of knowledge relating to this recent advance in metallurgical practice.

GEO. CRADOCK & CO., LTD., of Wakefield, have published a new elaborate catalogue of their wire ropes and of the many applications of wire ropes. This firm's ropes are well-known among mining men and oil drillers, as well as among civil engineers and in shipping circles. The firm also specializes in the construction of cable traction and in aerial ropeways. This catalogue gives complete descriptive and statistical information relating to the firm's products.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., of East Pittsburgh, in order to satisfy a demand for high-grade small-size indicating instruments, have developed and are now producing a new type known as type "CX" ammeters and voltmeters. These complete the new line of direct-current instruments manufactured by the company. The full line now consists of types BX, CX, DX, and SX, having over-all dimensions of $2\frac{9}{16}$, $3\frac{1}{2}$, $4\frac{3}{8}$, and $7\frac{7}{16}$ in. respectively. All instruments of this X line employ the same design construction differing only in linear dimensions. In this way uniformity of construction is obtained, which results in the very highest quality both in construction and accuracy. The type "CX" instruments are especially suitable for use on switchboard panels, for radio communication sets and farm lighting, and other small charging and lighting panels as well as for use on marine, dental, telephone, and telegraph panels. They are also furnished for use with a magneto to indicate speed and with search coils to indicate temperature. These instruments are capable of standing vibration such as is found on shipboard without impairing their accuracy or reliability, a combination of ruggedness and lightness of moving parts being provided in their construction. The case is punched from sheet metal and is made moisture-proof. An external zero adjustor on each instrument enables the operator to reset the zero position of the pointer if it is displaced by transport or shock. All parts are mounted on a moulded sub-base, assuring sufficient insulation. The instrument is fastened to the panel by means of three machine screws furnished with the instrument. The standard finish is dull black marine. The ammeters are self-contained for currents up to 30 amperes, but can be used with external shunts for higher currents. The voltmeters are self-contained up to 50 volts, but can be supplied for higher voltage with external resistance. The voltmeters have a resistance of 65 ohms per volt in series with the winding. This resistance has a zero temperature coefficient, and can be adjusted to obtain correct calibration.

METAL MARKETS

COPPER.—At the beginning of August, a firm tone ruled on the standard copper market in London, and prices had an upward tendency. Business on 'Change was active, a large daily turnover being seen. Optimism was encouraged by the realization that American producers had got the position well under their control, that the general copper position was quite sound, that demand from English consuming works was beginning to revive, and that at long last something definite was going to be done by the Allies to settle the deadlock of the reparations and debts question. Sentiment received a setback, however, at the failure of the London Conference, and the panic which subsequently manifested itself in the Continental exchanges reacted on the copper market. The violent fall in the mark had its repercussion in America, where producers found that their most important European customer—Germany—was losing its purchasing power. The end of the month accordingly saw somewhat weak conditions in the copper markets, and although standard underwent a slight upward reaction during the closing days, a fall was recorded on balance. The American market for electrolytic copper closed the month also with a distinctly less firm tendency, owing to the belated effects of the coal and rail disputes making themselves felt. One of the members of the Copper Export Association, the Nichols Company, seceded from that organization during August, an indication that competition instead of co-operation may soon be a feature of the policy of American producers, which of course would not be a bull point for values.

London Daily Metal Prices: Official Closing

Copper, Lead, Zinc, and Tin per Long Ton

Copper

	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
Aug.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
10	64 2 6 to 64 5 0	64 5 0 to 64 7 6	70 10 0 to 71 10 0	71 10 0	—
11	64 2 6 to 64 5 0	64 5 0 to 64 7 6	70 10 0 to 71 10 0	71 10 0	66 10 0 to 68 10 0
14	64 2 6 to 64 5 0	64 5 0 to 64 7 6	70 0 0 to 71 0 0	71 0 0	—
15	63 17 6 to 64 0 0	64 0 0 to 64 2 6	70 0 0 to 71 0 0	71 0 0	66 10 0 to 68 10 0
16	64 5 0 to 64 7 6	64 7 6 to 64 10 0	70 5 0 to 71 5 0	71 5 0	—
17	64 0 0 to 64 2 6	64 2 6 to 64 5 0	70 0 0 to 71 0 0	71 0 0	—
18	63 17 6 to 64 0 0	64 0 0 to 64 2 6	70 0 0 to 71 0 0	71 0 0	66 10 0 to 68 10 0
21	63 15 0 to 63 17 6	63 17 6 to 64 0 0	69 15 0 to 70 15 0	70 15 0	—
22	63 10 0 to 63 12 6	63 12 6 to 63 15 0	69 15 0 to 70 15 0	70 15 0	66 0 0 to 68 0 0
23	63 2 6 to 63 5 0	63 2 6 to 63 5 0	69 5 0 to 70 5 0	70 5 0	—
24	62 7 6 to 62 10 0	62 10 0 to 61 12 6	69 0 0 to 70 0 0	70 0 0	—
25	61 12 6 to 61 15 0	61 15 0 to 61 17 6	68 0 0 to 69 0 0	69 0 0	65 0 0 to 67 0 0
28	62 0 0 to 62 2 6	62 5 0 to 62 7 6	68 10 0 to 69 10 0	69 10 0	—
29	62 10 0 to 62 12 6	62 15 0 to 62 17 6	68 15 0 to 69 15 0	69 15 0	65 10 0 to 67 10 0
30	62 17 6 to 63 0 0	63 2 6 to 63 5 0	69 0 0 to 70 0 0	70 0 0	—
31	62 15 0 to 62 17 6	63 0 0 to 63 2 6	69 5 0 to 70 5 0	70 5 0	—
Sept.					
1	63 2 6 to 63 5 0	63 7 6 to 63 10 0	69 10 0 to 70 10 0	70 10 0	66 0 0 to 68 0 0
4	63 2 6 to 63 5 0	63 7 6 to 63 10 0	70 0 0 to 70 15 0	70 15 0	—
5	63 0 0 to 63 2 6	63 7 6 to 63 10 0	70 5 0 to 70 15 0	70 15 0	66 0 0 to 68 0 0
6	63 0 0 to 63 2 6	63 7 6 to 63 10 0	70 10 0 to 71 0 0	71 0 0	—
7	63 2 6 to 63 5 0	63 10 0 to 63 12 6	70 10 0 to 71 0 0	71 0 0	—
8	63 2 6 to 63 5 0	63 10 0 to 63 12 6	70 15 0 to 71 5 0	71 5 0	66 0 0 to 68 0 0

Average price of cash standard copper: August, 1922, £63 16s. 9d.; July, 1922, £63 3s. 7d.; August, 1921, £68 12s. 8d.; July, 1921, £71 4s. 4d.

TIN.—Values of tin underwent little alteration during the month, such oscillations as actually occurred being more attributable to the operations of dealers and speculators than to any actual change in the position of the metal. Such a large option account exists in the market at the present time that this state of affairs is certain to rule for some time to come. Quotations showed a slight loss on the month, but this cannot be regarded as indicating any distinct tendency on the part of values. At the moment, the big professional interests appear to be leaving the market alone, and their view would seem to be that values are unlikely to rise appreciably just yet. Sentiment was a little strengthened by the fact that visible supplies last month revealed a substantial decrease. Business with consumers generally remained dull. Continental buying was naturally restricted, in view of the political position and the chaotic state of the exchanges. Home consumers took only a subdued interest in the market, and American inquiry was also poor. The future of the market during coming months must depend to no small extent upon the American capacity to purchase. During the first six months of this year, the takings of the United States were on a record scale, but the recent strikes have interfered with industry, and it is becoming doubtful whether the market will receive as much American support in the near future as it did in the earlier part of the year.

Average price of cash standard tin: August, 1922, £160 1s. 0d.; July, 1922, £156 4s. 4d.; August, 1921, £155 8s. 4d.; July, 1921, £164 13s. 1d.

LEAD.—Values of lead on the London market fluctuated appreciably during the month, a moderate loss being sustained on balance. This was partly due to the fact that arrivals of fresh metal were on a rather more generous scale, while consumption tended to fall off owing to the holidays. It is probable that but for the control exercised by holders the market would have weakened further. Doubtless, there exist fair quantities of metal in the hands of holding interests, but these are not offered with any readiness, and a premium of about 12s. 6d. is still demanded for prompt over forward delivery. The immediate outlook is somewhat obscure, owing to the fact that it is very difficult to form an opinion as to whether world supplies will be likely to increase or not just yet, as the necessary information is not easy to obtain. Mexico, Spain, and Australia are three of the largest producers, and labour and political troubles are so frequent there that the supply of fresh metal from those countries is always attended with some uncertainty. Holders, however, appear to anticipate a continuance of stringent conditions. Consumers, on the other hand, are in many cases distrustful of the position and consider the market to be distinctly artificial.

Average price of soft foreign lead: August, 1922, £24 3s. 10d.; July, 1922, £24 6s. 11d.; August, 1921, £23 5s. 1d.; July, 1921, £23 5s. 10d.

SPELTER.—In this market also the general tendency of prices was downward. The chief reason for this was the announcement that the American coal stoppage had had the effect of restricting consumption, whereas the operations of the smelters (many of whom employ natural gas as fuel) were fully maintained. Consequently, with the possibility of larger American offerings, sentiment in London became somewhat pessimistic, and prices tended to droop. Otherwise the position has undergone little alteration. Continental offers continued restricted, but on the other hand British consumers displayed only a subdued interest, as usual. The output of the British smelters is doubtless expanding gradually, but this is still insufficient appreciably to sway the course of quotations on the London market. So far, the depreciation in Continental exchanges has not had the effect of bringing out increased offers from that side, but it remains to be seen whether such a result will ultimately materialize.

Average price of spelter: August, 1922, £30 16s. 3d.; July, 1922, £28 18s. 5d.; August, 1921, £25 8s.; July, 1921, £26 12s.

PRICES ON THE LONDON METAL EXCHANGE.
Silver per Standard Ounce; Gold per Fine Ounce.

Date	Lead: Soft Foreign (£ s. d. to £ s. d.)	Lead: English (£ s. d.)	Zinc (Spelter) (£ s. d. to £ s. d.)	Standard Tin: Cash (£ s. d. to £ s. d.)	Standard Tin: 3 mos. (£ s. d. to £ s. d.)	Silver: Cash (d.)	Silver: Forward (d.)	Gold (s. d.)
Aug. 10	24 15 0 to 24 0 0	26 5 0	31 2 6 to 30 2 6	159 2 6 to 159 5 0	159 7 6 to 159 10 0	34¼	34¼	92 6
11	24 7 6 to 23 12 6	26 0 0	30 17 6 to 30 0 0	158 10 0 to 158 15 0	158 15 0 to 159 0 0	34¼	34⅝	92 5
14	24 10 0 to 23 15 0	26 0 0	31 2 6 to 30 5 0	158 15 6 to 158 17 6	158 17 6 to 159 0 0	34½	34½	92 5
15	24 7 6 to 23 15 0	26 0 0	31 0 0 to 30 5 0	158 17 6 to 159 0 0	159 0 0 to 159 5 0	35	34⅞	92 4
16	24 10 0 to 23 15 0	26 0 0	31 10 0 to 30 10 0	160 12 6 to 160 15 0	160 15 0 to 160 17 6	35	35	92 3
17	24 12 6 to 23 17 6	26 0 0	31 12 6 to 30 12 6	161 10 0 to 161 12 6	161 12 6 to 161 15 0	34⅞	34⅞	92 1
18	24 15 0 to 24 0 0	26 0 0	31 10 0 to 30 15 0	161 12 6 to 161 15 0	161 12 6 to 161 15 0	34¾	34¾	92 0
21	24 15 0 to 23 17 6	26 0 0	31 10 0 to 30 12 6	161 2 6 to 161 5 0	161 5 0 to 161 7 6	35	35	92 0
22	24 12 6 to 23 15 0	26 0 0	31 5 0 to 30 7 6	160 5 0 to 160 7 6	160 7 6 to 160 10 0	34¾	34¾	92 0
23	24 7 6 to 23 10 0	26 0 0	31 5 0 to 30 7 6	160 0 0 to 160 2 6	160 2 6 to 160 5 0	34¾	34¾	92 1
24	24 0 0 to 23 2 6	25 10 0	30 15 0 to 30 2 6	158 15 0 to 158 17 6	158 17 6 to 159 0 0	35⅛	35	92 2
25	23 7 6 to 22 15 0	25 0 0	30 2 6 to 29 10 0	157 10 0 to 157 15 0	157 12 6 to 157 15 0	35⅛	35⅛	92 2
28	23 15 0 to 23 0 0	25 0 0	30 12 6 to 30 2 6	158 7 6 to 158 10 0	158 10 0 to 158 12 6	35⅛	35⅛	92 3
29	24 0 0 to 23 7 6	25 5 0	30 17 6 to 30 7 6	159 10 0 to 159 12 6	159 15 0 to 159 17 6	35⅛	35⅛	92 7
30	24 5 0 to 23 12 6	25 10 0	30 15 0 to 30 5 0	160 7 6 to 160 15 0	160 12 6 to 160 15 0	35⅛	35⅛	92 4
31	24 5 0 to 23 12 6	25 10 0	30 17 6 to 30 7 6	160 10 0 to 160 12 6	160 15 0 to 160 17 6	35⅛	35⅛	92 4
Sept. 1	24 2 6 to 23 10 0	25 10 0	31 5 0 to 30 10 0	160 17 6 to 161 0 0	161 2 6 to 161 5 0	35⅛	35⅛	92 5
4	24 2 6 to 23 7 6	25 10 0	31 7 6 to 30 12 6	159 12 6 to 159 15 0	160 0 0 to 160 2 6	35⅛	35⅛	92 4
5	24 5 0 to 23 10 0	25 10 0	31 5 0 to 30 10 0	159 10 0 to 159 15 0	159 17 6 to 160 0 0	35⅜	35⅜	92 3
6	24 5 0 to 23 10 0	25 10 0	31 7 6 to 30 12 6	159 10 0 to 159 12 6	159 17 6 to 160 0 0	35¼	35¼	92 2
7	24 5 0 to 23 7 6	25 10 0	31 7 6 to 30 12 6	159 15 0 to 160 0 0	160 5 0 to 160 7 6	35⅜	35¼	92 4
8	24 5 0 to 23 7 6	25 10 0	31 10 0 to 30 15 0	159 12 6 to 159 15 0	160 2 6 to 160 5 0	35¼	35¼	92 5

ZINC DUST.—Prices are nominally unchanged: Australian high-grade, £50; American 92 to 94%, £47 10s.; and English 90 to 92%, £47 10s.

ANTIMONY.—English regulus is unaltered, with ordinary brands priced at £27 to £29 10s. and special brands at £32 10s. to £35. Foreign material is quiet, with spot quoted at £23 10s., while for shipment from the East a few shillings less is quoted, c.i.f.

ARSENIC.—Supplies are scarce, and although demand is dull, holders have put up their quotation to £45 to £47 10s. per ton, delivered London, for Cornish white, 99%.

BISMUTH.—The price is steady at 9s. per lb. for 5 cwt. lots and over.

CADMIUM.—A certain amount of business is passing at 5s. 6d. to 5s. 9d. per lb.

ALUMINIUM.—Home producers quote £100 per ton for home and £105 for export, but demand appears to be slack. Foreign material is offering at about £85 f.o.b. Continent, but there is not much interest taken.

NICKEL.—The price is down again to £145 per ton for both home and export orders.

COBALT METAL.—12s. is nominally quoted, but for substantial orders down to 10s. 6d. per lb. would probably be accepted.

COBALT OXIDES.—Steady at 10s. per lb. for grey and 9s. for black.

PLATINUM.—Prices are firmer, with sponge quoted around £19 per oz. and manufactured material at up to £24.

PALLADIUM.—Raw metal £13 nominal; manufactured (sheets and wire, etc.) £19 10s. per oz. A fair demand is reported.

QUICKSILVER.—Prices are firmer at £12 15s. per bottle, on spot.

SELENIUM.—Powder is steady at 7s. 9d. per lb.

TELLURIUM.—The market is quiet but unchanged, sellers quoting 40s. per lb.

MANGANESE ORE.—The market has a firm tendency, Indian grades being priced at 1s. 2d. to 1s. 2½d. per unit, c.i.f., for this year's shipment. Caucasian ordinary grades are also firm at 1s. 2¼d. to 1s. 2½d.

CHROME ORE.—Values are well maintained, 48 to 50% being priced at £4 to £4 5s. c.i.f.

SULPHATE OF COPPER.—The quotation is fairly steady at £26 10s. to £27 per ton, for both home and export business.

TUNGSTEN ORE.—Spot material is called 14s. to 15s., while a fair quotation for forward shipment is 13s. 6d. to 13s. 9d. c.i.f.

MOLYBDENITE.—Supplies are scarce, and although there are buyers about at 45s., sellers are inclined to hold for higher figures.

SILVER.—The market was steady and quiet during August, being chiefly dependent on India for support, which was not always forthcoming. Other countries, however, did not feature as very insistent sellers, so that equilibrium was maintained. Spot bars opened at 35⅛d. on August 1, receded till 34½d. was reached on the 14th, recovered to 35d. on the 15th, and then subsequently oscillated within a very small margin around that figure, closing at 35⅛d. on August 31.

GRAPHITE.—The market is dull, with sellers still quoting £13 per ton for Madagascar, 80 to 90%.

IRON AND STEEL.—The holiday periods have interfered considerably with business in iron and steel, but now that these vacations are over, traders are confidently hoping for some substantial autumn buying. America has purchased fair quantities of pig iron, but exports in general are quiet, mainly owing to the fact that the Continent is not in a position to purchase. There are considerable stocks of Cleveland foundry iron on hand, but makers are not inclined to grant concessions, and quote No. 3 G.M.B. at 87s. to 87s. 6d. for either home or export. East Coast hematite is quoted at about 89s. to 90s. In manufactured material business has been dull generally, but there are signs that consumers will shortly come forward to place their autumn requirements. Not much has been moving in the home trade naturally, as works have been closed for holidays at various periods, while export trade in general has been dull. The fixing of prices for the home trade is gradually disappearing, and makers are now free to quote as they like.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of Gold per oz.
	Oz.	Oz.	Oz.	s. d.
August, 1921	695,230	16,296	711,526	111 6
September.......	674,157	16,939	691,096	110 0
October	690,348	17,477	707,825	103 0
November	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921......	7,924,534	190,052	8,114,586	—
January, 1922 . } February...... } March .... }	594,788	44,940	639,728	95 6 / 92 6 / 94 0
April	493,492	17,936	511,338	92 0
May	612,702	17,083	629,786	92 0
June	658,032	17,665	675,697	92 6
July	713,068	17,567	730,635	92 0

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
May 31, 1921........	170,595	14,510	1,302	186,407
June 30	168,152	14,704	1,317	184,173
July 31	166,999	14,688	1,246	182,933
August 31	169,008	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,410	13,465	1,217	191,092
December 31........	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169
June 30	170,464	12,117	1,211	183,792
July 31	172,886	12,371	1,211	186,468

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
July, 1921 ...	2,010,236	37 2	25 7	11 7	1,163,565
August	2,050,722	37 3	25 4	11 11	1,226,282
September ...	1,997,086	36 8	25 2	11 6	1,151,127
October......	2,041,581	34 4	24 9	9 7	981,597
November ..	2,007.617	34 6	24 9	9 9	978,931
December....	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922 } February .. } March .... }	1,624,333	33 10	49 0	15 2*	1,233,033*
April	1,414,843	31 7	24 3	7 4	519,365
May.........	1,772,793	31 4	22 8	8 8	767,533
June	1,882,837	31 10	22 8	9 2	862,575

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May............	46,266	48,744	53,920
June	45,054	49,466	55,614
July	46,208	51,564	54,191
August	48,740	53,200	—
September	45,471	52,436	—
October	47,343	53,424	—
November	46,782	53,098	—
December	46,190	55,968	—
Total ..	552,498	591,525	377,649

Transvaal Gold Outputs.

	June		July	
	Treated Tons	Yield Oz.	Treated Tons	Yield Oz.
Aurora West..........	8,740	£12,438†	9,500	£12,988*
Brakpan	58,000	25,816	64,500	26,303
City Deep	86,000	36,513	88,500	38,480
Cons. Langlaagte	35,900	£48,188†	41,100	£53,345*
Cons. Main Reef	44,600	15,871	52,100	20,424
Crown Mines..........	172,000	53,049	214,000	62,572
D'rb'nRoodepoortDeep	27,500	9,321	31,000	10,731
East Rand P.M........	106,500	26,648	119,000	30,559
Ferreira Deep	26,200	7,004	30,500	8,637
Geduld...............	44,600	16,257	46,300	16,359
Geldenhuis Deep	52,787	12,714	53,222	13,847
Glynn's Lydenburg ...	4,244	£6,488‡	3,276	6,662§
Goch	15,860	£16,958†	17,500	£17,634*
Government G.M. Areas	141,000	£285,522†	141,000	£283,025*
Kleinfontein	42,000	11,547	47,600	12,345
Knight Central........	28,500	5,833	32,000	6,447
Langlaagte Estate	42,300	£63,908†	49,350	£66,047*
Luipaard's Vlei	17,910	£19,249†	19,323	£19,206*
Meyer & Charlton	13,800	£36,468†	15,000	£38,506*
Modderfontein, New ..	106,000	48,183	108,000	49,656
Modderfontein B	60,000	32,665	62,000	34,379
Modderfontein Deep ..	43,300	23,180	43,200	23,408
Modderfontein East....	25,500	10,283	26,300	10,713
New Unified	10,600	£11,600†	11,200	£12,148*
Nourse	43,800	13,932	47,700	14,753
Primrose	17,800	£19,450†	19,100	£19,490*
Randfontein Central ..	119,500	£163,196†	133,500	£189,616*
Robinson.............	14,500	4,904	17,000	5,687
Robinson Deep	60,700	17,430	68,400	20,963
Roodepoort United ...	9,400	£8,299†	8,650	£7,863*
Rose Deep	47,200	12,360	50,500	12,625
Simmer & Jack	40,100	10,481	48,800	10,735
Springs	43,000	18,606	41,400	19,230
Sub-Nigel	10,000	6,050	10,400	5,970
Transvaal G.M. Estates.	15,490	£24,089‡	15,940	£23,623§
Van Ryn	32,200	£41,386†	34,300	£44,626*
Van Ryn Deep	55,100	£122,301†	55,000	£120,865*
Village Deep	54,100	16,632	54,600	17,667
West Rand Consolidated	31,000	£41,538†	34,500	£44,366*
Witw'tersr'nd (Knights)	39,600	£50,764†	46,200	£53,845*
Witwatersrand Deep ..	32,800	10,663	42,350	12,997
Wolhuter.............	32,500	7,889	33,700	8,010

* £4 12s. per oz. ‡ £4 10s. per oz. † £4 12s. 6*d*. per oz. § £4 10s. per oz.

Rhodesian Gold Outputs.

	June		July	
	Tons	Oz.	Tons	Oz.
Cam & Motor	14,800	5,472	15,000	5,604
Falcon	16,266	3,120‖	16,850	2,862*
Gaika	—	—	—	—
Globe & Phœnix	6,318	6,481	6,446	6,774
Jumbo	1,450	522	1,450	492
London & Rhodesian ..	—		3,423	£4,662
Lonely Reef	5,440	4,039	5,560	3,975
Planet-Arcturus	5,580	1,988	5,900	2,323
Rezende	5,900	2,895	6,100	2,940
Rhodesia G.M. & I. ..	233	176	229	179
Shamva	56,700	£36,783§	56,500	£37,471§
Transvaal & Rhodesian	1,655	£4,733†	1,520	£4,382†

* Also 274 tons copper. † At par. ‖ Also 296 tons copper.
Gold at £4 10s. per oz.

West African Gold Outputs.

	June		July	
	Tons	Oz.	Tons	Oz.
Abbontiakoon	6,920	£11,939*	7,720	£13,875*
Abosso	7,400	2,965	7,015	2,831
Ashanti Goldfields	6,083	5,277	7,800	5,391
Obbuassi	540	£2,100†	555	446
Prestea Block A.......	8,379	£15,760*	8,382	£15,738*
Taquah	2,024	1,155	2,500	1,327

* At par. † Including premium.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
November, 1921	156	46,429	46,585	197,879
December	451	53,348	53,799	228,522
January, 1922	329	37,851	38,180	162,177
February	926	41,194	42,120	178,913
March	180	42,842	43,022	182,745
April	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June	136	49,158	49,294	209,386
July	366	42,774	43,140	183,247
August	1,051	48,638	49,689	211,064

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	oz.	oz.	oz.	£
January	38,181	4,411	448	11,855
February	42,121	8,063	1,200	12,325
March	43,022	11,717	1,069	12,960
April	46,394	4,186	6,219	6,589
May	39,725	10,049	7,636	13,100
June	49,294	12,058	12,181	6,784
July	43,140	—	—	—
August	—	—	—	—
September	—	—	—	—
October	—	—	—	—
November	—	—	—	—
December	—	—	—	—
Total	301,877	50,487	28,753	63,613

Australasian Gold Outputs.

	June		July	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	6,135	7,444‖	5,993	8,745‖
Blackwater (N.Z.)	3,620	6,689*	3,694	7,443*
Gold'n Horseshoe (W.A)	10,320	5,530‡	9,648	5,362‡
Grt Boulder Pro. (W.A.)	9,540	26,712‖	10,024	27,316‖
Hampton Celebr. (W.A.)	870	1,859‖	1,006	1,856‖
Ivanhoe (W.A.)	15,893	6,498‡	16,070	6,279‡
Lake View & Star (W.A.)	6,862	11,792‖	—	—
Menzies Con. (W.A.)	2,000	3,804	1,960	3,462
North Kalgurli (W.A.)	—	—	—	—
Oroya Links (W.A.)	—	—	3,321	15,082†s
South Kalgurli (W.A.)	7,544	12,743‖	6,821	11,936‖
Waihi (N.Z.)	15,156	4,328‡ 30,247§	15,342	4,419‡ 29,577§
„ Grand Junc'n (N.Z.)	—	—	—	—

* Including premium; † Including royalties; ‡ Oz. gold § Oz. silver; ‖ At par; s six weeks to July 31.

Miscellaneous Gold and Silver Outputs.

	June		July	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	206p	—	430p§
Colombian Mining (C'lbia)	2,100	5,045	4,416	6,704
El Oro (Mexico)	34,151	175,757†	35,190	183,621†
Esperanza (Mexico)	—	1,979e	—	3,843e
Frontino & Bolivia (C'lbia)	2,090	7,338	1,980	8,092
Keeley Silver (Canada)	—	37,500s	—	67,750s
Mexico El Oro (Mexico)	13,315	247,660†	13,313	249,470†
Mining Corp. of Canada	—	—	—	—
Oriental Cons. (Korea)	16,322	78,000†	—	75,000†
Ouro Preto (Brazil)	6,800	2,830	7,500	2,944
Plym'th Cons. (Calif'rnia	8,200	9,074*	8,000	8,979*
St. John del Rey (Brazil).	—	38,000*	—	39,500*
Santa Gertrudis (Mexico)	40,868	65,705e	40,510	52,824e
Tomboy (Colorado)	18,000	76,000†	15,000	61,000†

* At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. p Oz. platinum and gold. s Oz. silver. e Profit in dollars. § Eight weeks to August 12.
Nechi (Colombia): 18 days to August 7, $13,223 from 91,104 cu. yd.

Gold Outputs, Kolar District, India.
During July, 1922.

	Tons Ore	Oz.	Tons Tailing	Oz.	Total Oz.
Balaghat	3,600	1,902	8,700	752	2,654
Champion Reef	12,479	3,373	23,446	1,098	4,471
Mysore	18,500	6,252	49,186	4,252	10,504
North Anantapur.	980	1,017	700	76	1,093
Nundydroog	9,715	4,384	16,280	708	5,092
Ooregum	13,000	7,561	13,600	894	8,455

Total Gold Output for all India: February, 34,690 oz.; March, 35,607 oz.; April, 35,583 oz.; May, 36,120 oz.

Base Metal Outputs.

		June	July
British Broken Hill	Tons lead carb. ore.	420	200
	Tons lead conc.	2,464	1,130
	Tons zinc conc.	2,260	1,080
Broken Hill Prop	Tons lead conc.	1,308	1,837
	Tons zinc conc.	6,301	5,738
Broken Hill South	Tons lead conc.	4,725	6,622†
Burma Corporation	Tons refined lead	3,281	3,405
	Oz. refined silver	379,683	361,514
Electrolytic Zinc	Tons zinc	1,981	1,965
Fremantle Trading	Tons lead	401	400
Mount Lyell	Tons copper	489	450
	Oz. silver	9,434	9,086
	Oz. gold	112	118
Mount Morgan	Tons copper	708*	460
	Oz. gold	6,950*	4,122
North Broken Hill	Tons lead conc.	2,075	1,750
	Tons zinc conc.	1,840	1,720
Poderosa	Tons copper ore	550	550
Rhodesia Broken Hill	Tons lead	1,822	1,873
San Francisco Mexico	Tons lead conc.	1,950	1,520
	Tons shipping ore	38	—
Sulphide Corporation	Tons lead conc.	3,378	2,670
	Tons zinc conc	5,983	3,822
Union Minière	Tons copper	—	4,061
Transvaal Silver	Tons silver-lead bullion	397	321
Zinc Corporation	Tons zinc conc.	9,035	8,995
	Tons lead conc.	950	767

* Six weeks to June 25. † Six weeks to August 12.

Imports of Ores, Metals, etc., into United Kingdom.

		June	July
Iron Ore	Tons	270,924	287,213
Manganese Ore	Tons	18,798	27,415
Iron and Steel	Tons	52,797	55,893
Copper and Iron Pyrites	Tons	22,840	35,961
Copper Ore, Matte, and Prec.	Tons	2,402	1,537
Copper Metal	Tons	4,061	5,226
Tin Concentrate	Tons	4,202	1,944
Tin Metal	Tons	1,592	3,217
Lead, Pig and Sheet	Tons	10,437	15,059
Zinc (Spelter)	Tons	6,088	6,983
Zinc Sheets, etc.	Tons	822	847
Quicksilver	Lb.	63,428	93,740
Zinc Oxide	Tons	349	465
White Lead	Cwt.	9,845	12,405
Red and Orange Lead	Cwt.	3,155	1,944
Barytes, ground	Cwt.	44,566	40,218
Asbestos	Tons	1,376	1,122
Boron Minerals	Tons	677	3,997
Borax	Cwt.	3,005	3,299
Basic Slag	Tons	7,580	10,117
Phosphate of Lime	Tons	40,517	32,944
Mica	Tons	118	91
Sulphur	Tons	3,946	2,719
Nitrate of Soda	Cwt.	20,749	42,464
Potash Salts	Cwt.	170,784	136,244
Petroleum: Crude	Gallons	8,210,641	27,035,098
Lamp Oil	Gallons	7,256,603	16,586,107
Motor Spirit	Gallons	33,376,261	26,944,979
Lubricating Oil	Gallons	5,365,168	7,270,568
Gas Oil	Gallons	9,160,832	3,536,220
Fuel Oil	Gallons	29,589,999	39,478,912
Asphalt and Bitumen	Tons	17,031	[illegible]
Paraffin Wax	Cwt.	70,830	102,406
Turpentine	Cwt.	45,220	[illegible]

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	May	June	July
	Tons	Tons	Tons
Nigeria:			
Bisichi	22½	32	31
Ex-Lands	30	30	30
Filani	2	1½	1
Gold Coast Consolidated	—	—	—
Gurum River	9	8	7
Jos	10½	10½	11½
Kaduna	3¼	3	3¾
Kaduna Prospectors	4¾	5	6½
Keffi Consolidated	20	20	20
Lower Bisichi	4	6½	9¾
Mongu	30	25	30
Naraguta	37	50	50
Naraguta Extended	8	15	26
Nigerian Consolidated	7	8½	9
N.N. Bauchi	45	56	60
Rayfield	40	50	40
Ropp	180	163	111
Rukuba	3	2	2
South Bukeru	20	12	5
Tin Fields	—	6	8
Yarde Kerri	8	5	3
Federated Malay States:			
Chenderiang	—	74*	—
Gopeng	72	62½	68½
Idris Hydraulic	18¼	19	20¾
Ipoh	24½	18¾	18½
Kamunting	—	86*	—
Kinta	37	34¼	32¾
Lahat	37¾	34¾	34
Malayan Tin	77½	80¼	92¼
Pahang	219½	215	200
Rambutan	20	19½	21
Sungei Besi	39	42	50
Tekka	36	31	36
Tekka-Taiping	23	15	12½
Tronoh	89	74	78¾
Other Countries:			
Aramayo Mines (Bolivia)	249	219	225
Berenguela (Bolivia)	34	34	41
Briseis (Tasmania)	—	—	—
Deebook Ronpibon (Siam)	21	21	21
Leeuwpoort (Transvaal)	—	10	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	66	—	35
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	120	116	125
Tongkah Harbour (Siam)	98	115	[illegible]
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	667	678	613	547	438	473
February	646	668	623	477	370	412
March	655	707	606	565	445	456
April	555	584	546	467	394	434
May	560	525	483	383	337	485
June	[illegible]	492	484	435	423	509
July	[illegible]	545	481	484	494	467
August	[illegible]	571	616	447	477	—
September	538	520	561	528	595	—
October	578	491	625	628	546	—
November	621	472	536	544	564	—
December	655	518	511	577	535	—
Total	6,927	[illegible]	6,685	6,022	5,618	[illegible]

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,030	3,765	4,265	3,298	3,143
February	3,197	2,734	3,014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	2,909
July	3,373	3,756	2,824	2,734	—
August	3,259	2,956	2,786	3,051	—
September	3,157	3,161	2,734	2,338	—
October	2,870	3,221	2,837	3,161	—
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	17,463

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	June 30	July 31	Aug. 31
Straits and Australian Spot	1,151	2,361	2,694
Ditto, Landing and in Transit	670	475	225
Other Standard, Spot and Landing	4,690	4,254	4,195
Straits, Afloat	2,555	650	1,025
Australian, Afloat	45	75	75
Banca, in Holland	2,776	2,700	2,624
Ditto, Afloat	1,214	459	735
Billiton, Spot	60	27	27
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	572	610	650
Total Afloat for United States	6,452	5,137	6,697
Stock in America	2,371	2,616	2,806
Total	22,558	20,364	21,753

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	June	July	Aug.
Shipments from:			
Straits to U.K.	2,595	720	1,060
Straits to America	3,465	2,890	4,160
Straits to Continent	115	425	635
Straits to other places	100	150	125
Australia to U.K.	—	50	25
U.K. to America	355	490	50
Imports of Bolivian Tin into Europe	2,462	202	1,640
Supply:			
Straits	6,505	4,035	4,035
Australian	—	50	50
Billiton	—	—	
Banca	1,229	846	846
Standard	545	684	684
Total	8,279	5,615	5,615
Consumption:			
U.K. Deliveries	1,929	2,420	2,420
Dutch ,,	299	313	313
American ,,	5,130	4,590	4,590
Straits, Banca & Billiton, Continental Ports, etc.	598	486	486
Total	7,956	7,809	7,809

Imports and Exports of Gold and Silver

During July, 1922.

		Imports.	Exports.
Gold:	Unrefined Bullion .... £	397,845	—
	Refined Bars .... ,,	2,419,635	9,482,369
	Coin .... ,,	450	32,280
Silver:	Unrefined Bullion ... oz.	150,067	—
	Refined Bars .... ,,	2,130,104	4,940,200
	Coin .... £	—	115,451

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

IN TONS.

	May	June.	July
Anglo-Egyptian	15,564	17,893	8,607
Anglo-Texas	1,922	1,994	1,904
Anglo-United	—	—	—
Apex Trinidad	7,600	5,000	7,300
Astra Romana	35,400	32,800	32,542
British Burmah	10,633	10,084	10,202
Caltex	11,613	10,348	—
Dacia Romana	798	553	786
Indo-Burma	—	—	—
Kern River	15,814	12,339	13,394
Lobitos	8,903	8,697	8,845
Phœnix	3,216	6,289	5,830
Romana Americana	26,300	25,300	13,145
Roumanian Consolidated	2,307	1,814	—
Santa Maria	1,629	1,415	1,471
Steaua Romana	18,697	18,427	19,170
Trinidad Leaseholds	9,550	8,500	8,600
United of Trinidad	3,293	3,924	4,683

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Aug. 4, 1922			Sept. 6, 1922		
	£	s.	d.	£	s.	d.
Anglo-American	4	5	0	4	10	0
Anglo-Egyptian B	1	6	0	1	10	0
Anglo-Persian 1st Pref.	1	5	6	1	6	0
Apex Trinidad	2	0	0	2	3	9
British Borneo (10s.)		10	6		13	9
British Burmah (8s.)		10	6		11	3
Burmah Oil	5	0	0	5	17	6
Caltex ($1)		1	9		1	6
Dacia Romano		17	6		15	0
Kern River, Cal. (10s.)	1	0	3	1	2	0
Lobitos, Peru	5	7	6	5	16	3
Mexican Eagle, Ord. ($5)	2	14	0	3	8	9
,, ,, Pref. ($5)	2	11	3	3	5	0
North Caucasian (10s.)		10	6		15	0
Phœnix, Roumania	1	6	6	1	0	0
Roumanian Consolidated		17	6		15	9
Royal Dutch (100 gulden)	36	0	0	39	10	0
Scottish American		2	0		2	0
Shell Transport, Ord.	4	6	0	4	12	6
,, ,, Pref. (£10)	9	15	0	9	15	0
Trinidad Central	1	11	3	2	0	0
Trinidad Leaseholds	1	0	0	1	6	3
United British of Trinidad		8	9		10	0
Ural Caspian		12	0		13	9
Uroz Oilfields (10s.)		8	0		10	0

PETROLEUM PRODUCTS PRICES. September 8.

REFINED PETROLEUM: Water white, 1s. 2d. per gallon; standard white, 1s. 1d. per gallon; in barrels 3d. per gallon extra.

MOTOR SPIRIT: In bulk: Aviation spirit, 2s. 6d. per gallon; No. 1, 2s. 2d. per gallon; No. 2, 2s. per gallon.

FUEL OIL: Furnace fuel oil, £3 5s.: Diesel oil, £4 2s. 6d. per ton.

AMERICAN OILS: Best Pennsylvania crude at wells, $3·00 per barrel. Refined standard white for export in bulk, 5·5 cents per U.S. gallon; in barrels 11·5 cents. Refined water white for export in bulk, 6·5 cents per U.S. gallon; in barrels 12·5 cents.

DIVIDENDS DECLARED BY MINING COMPANIES

During month ended September 10.

Company	Par Value of Shares	Amount of Dividend
Balaghat	Pref. 10s.	1s. less tax.
Broken Hill South	£1	2s. less tax.
Central Provinces Prospecting	£1	10% tax paid.
Eastern Smelting	Pref. Ord. £1	10% less tax.
Mysore	10s.	9d. less tax.
Nechi Mines	Pref. 10s.	7½d. less tax.
North Anantapur	Ord. £1	1s. less tax.
Nundydroog	10s.	6d. less tax.
Oroville Dredging	£1	9d less tax.
Ouro Preto	Pref. £1	10% less tax.
Talisman Consolidated	£1	11¼d.*
Wankie Colliery	10s.	5% less tax.
Witbank Colliery	£1	10% less tax.

* Third and last instalment of return of capital on liquidation.

PRICES OF CHEMICALS. September 5.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	0
,, 80%	,,	1	18	0
,, Glacial	per ton	65	0	0
Alum	,,	14	0	0
Alumina, Sulphate	,,	11	0	0
Ammonia, Anhydrous	per lb.		2	2
,, 0·880 solution	per ton	25	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	35	0	0
,, ,, pure	per cwt.	3	5	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	70	0	0
,, Sulphate	,,	16	0	0
Antimony, Tartar Emetic	per lb.		1	7
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	41	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			7
,, Chloride	per ton	22	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		1	11
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	13	0	0
,, Liquor, 7%	,,	4	10	0
Borax	,,	29	0	0
Boric Acid Crystals	,,	60	0	0
Calcium Chloride	,,	7	0	0
Carbolic Acid, crude 60%	per gal.		1	10
,, ,, crystallized, 40°	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		2	2
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100%	per lb.			10½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	8	10	0
,, Sulphate	,,	2	10	0
Lead, Acetate, white	,,	40	0	0
,, Nitrate	,,	42	0	0
,, Oxide, Litharge	,,	39	0	0
,, White	,,	42	0	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey 80%	,,	13	10	0
Magnesite, Calcined	,,	12	0	0
Magnesium, Chloride	,,	8	0	0
,, Sulphate	,,	8	0	0
Methylated Spirit 64° Industrial	per gal.		2	8
Nitric Acid, 80° Tw.	per ton	26	0	0
Oxalic Acid	per lb.			8
Phosphoric Acid	per ton	40	0	0
Potassium Bichromate	per lb.			6½
,, Carbonate	per ton	29	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	12	0	0
,, Hydrate (Caustic) 90%	,,	29	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			9
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	3
,, Sulphate, 90%	per ton	15	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate 45%	,,	32	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			6
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			3½
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	11	0	0
,, Nitrate, 96%	,,	15	0	0
,, Phosphate	,,	17	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	15	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salts)	,,	4	10	0
,, Sulphide	,,	22	0	0
,, Sulphite	,,	10	0	0
Sulphur, Roll	,,	10	0	0
,, Flowers	,,	10	10	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 30%	,,	4	0	0
Tartaric Acid	per lb.		1	4
Turpentine	per cwt.	4	14	3
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	0
Zinc Chloride	per ton	20	0	0
Zinc Oxide	,,	42	0	0
Zinc Sulphate	,,	13	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Sept. 7, 1921 £ s. d.	Sept. 6, 1922 £ s. d.
RAND:		
Anglo-American Corporation	1 2 6	1 6 3
Brakpan	2 16 3	2 13 9
Central Mining (£8)	7 0 0	9 10 0
City & Suburban (£4)	2 6	2 6
City Deep	2 11 3	2 13 9
Consolidated Gold Fields	1 1 3	1 2 6
Consolidated Langlaagte	16 3	18 6
Consolidated Main Reef	12 6	15 0
Consolidated Mines Selection (10s.)	17 6	19 0
Crown Mines (10s.)	2 5 0	2 17 6
Daggafontein	3 3	4 0
Durban Roodepoort Deep	6 0	13 0
East Rand Proprietary	6 0	12 9
Ferreira Deep	10 0	10 0
Geduld	2 10 0	3 7 6
Geldenhuis Deep	6 0	8 3
Government Gold Mining Areas	4 5 0	5 7 6
Johannesburg Consolidated	1 8 6	1 12 0
Kleinfontein	7 0	9 6
Knight Central	4 6	4 9
Langlaagte Estate	14 0	1 2 6
Luipaards Vlei	4 3	4 6
Meyer & Charlton	4 2 6	4 0 0
Modderfontein, New (10s.)	3 15 0	4 7 6
Modderfontein B (5s.)	1 10 0	1 15 0
Modderfontein Deep (5s.)	2 5 0	2 8 9
Modderfontein East	11 6	10 3
New State Areas	1 5 0	1 15 0
Nourse	9 9	18 0
Rand Mines (5s.)	2 10 0	3 3 9
Randfontein Central	13 0	17 3
Robinson (£5)	10 0	10 6
Robinson Deep A (1s.)	10 0	1 12 6
Rose Deep	13 9	16 6
Simmer & Jack	3 0	4 3
Springs	2 5 0	2 12 6
Sub-Nigel	11 3	13 6
Union Corporation (12s. 6d.)	16 9	1 2 6
Van Ryn	13 0	14 6
Van Ryn Deep	3 15 0	3 15 0
Village Deep	10 0	16 3
West Springs	13 9	15 9
Witwatersrand (Knight's)	13 9	17 6
Witwatersrand Deep	8 6	17 6
Wolhuter	4 0	4 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	8 6	15 0
Transvaal Gold Mining Estates	9 3	13 6
DIAMONDS IN SOUTH AFRICA:		
Consolidated of S.W.A.	—	19 0
De Beers Deferred (£2 10s.)	13 5 0	14 0 0
Jagersfontein	3 0 0	3 17 6
Premier Deferred (2s. 6d.)	5 15 0	5 5 0
RHODESIA:		
Cam & Motor	12 0	17 0
Chartered British South Africa	12 6	13 6
Falcon	5 3	6 0
Gaika	10 9	11 9
Globe & Phœnix (5s.)	13 0	13 3
Gold Fields Rhodesian (10s.)	6 0	6 9
Lonely Reef	2 10 0	2 2 6
Rezende	3 15 0	3 2 6
Shamva	1 12 6	1 10 0
WEST AFRICA:		
Abbontiakoon (10s.)	2 9	2 6
Abosso	9 0	7 6
Ashanti (4s.)	16 0	13 9
Prestea Block A	1 9	1 6
Taquah	9 0	7 6
WEST AUSTRALIA:		
Associated Gold Mines	2 6	6 9
Associated Northern Blocks	2 6	2 3
Bullfinch (5s.)	1 0	1 0
Golden Horse-Shoe (£5)	11 3	10 0
Great Boulder Proprietary (2s.)	6 0	4 6
Great Fingall (10s.)	1 6	1 0
Hampton Celebration	3 0	2 6
Hampton Properties	5 0	4 0
Ivanhoe (£5)	16 3	17 6
Lake View Investment (10s.)	8 9	11 3
Lake View and Star (4s.)	2 3	1 6
Oroya Links (5s.)	1 3	1 3
Sons of Gwalia	3 6	3 3
South Kalgurli (10s.)	5 6	7 6

GOLD, SILVER, *cont.*	Sept. 7, 1921 £ s. d.	Sept. 6, 1922 £ s. d.
NEW ZEALAND:		
Blackwater	2 6	5 0
Waihi	1 1 3	1 7 6
Waihi Grand Junction	8 9	8 9
AMERICA:		
British Platinum, Colombia	9 0	9 6
Camp Bird, Colorado	4 0	5 6
El Oro, Mexico	10 0	9 6
Esperanza, Mexico	17 6	13 3
Frontino & Bolivia, Colombia	6 3	10 0
Kirkland Lake, Ontario	12 6	13 0
Le Roi No. 2 (£5), British Columbia	2 6	2 6
Mexican Corporation, Mexico	—	8 6
Mexico Mines of El Oro, Mexico	4 10 0	5 0 0
Nechi (Pref. 10s.), Colombia	4 6	5 6
Oroville Dredging, Colombia	1 3 9	1 2 6
Ouro Preto, Brazil	12 6	14 6
Plymouth Consolidated, California	10 0	6 3
St. John del Rey, Brazil	13 9	18 9
Santa Gertrudis, Mexico	7 0	8 6
Tomboy, Colorado	5 0	9 6
RUSSIA:		
Lena Goldfields	8 9	7 6
Orsk Priority	5 0	5 0
INDIA:		
Balaghat (10s.)	7 3	9 0
Champion Reef (2s. 6d.)	1 0	7 3
Mysore (10s.)	11 3	13 3
North Anantapur	3 9	2 6
Nundydroog (10s.)	7 3	8 6
Ooregum (10s.)	12 6	15 0
COPPER:		
Arizona Copper (5s.), Arizona	1 10 0	17 6
Cape Copper (£2), Cape and India	17 6	10 0
Hampden Cloncurry, Queensland	6 3	6 3
Mason & Barry, Portugal	1 10 0	2 2 6
Messina (5s.), Transvaal	3 6	3 0
Mount Elliott (£5), Queensland	13 9	6 3
Mount Lyell, Tasmania	13 0	1 0 0
Mount Morgan, Queensland	12 6	12 6
Namaqua (£2), Cape Province	15 0	1 5 0
Rio Tinto (£5), Spain	30 10 0	29 0 0
Russo-Asiatic Consd., Russia	10 0	10 6
Sissert, Russia	7 6	4 6
Spassky, Russia	10 0	10 0
Tanganyika, Congo and Rhodesia	1 1 3	16 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	15 0	17 6
British Broken Hill	18 9	1 6 3
Broken Hill Proprietary	1 17 6	1 8 9
Broken Hill Block 10 (£10)	10 0	5 0
Broken Hill North	1 8 9	2 2 6
Broken Hill South	1 6 3	2 2 6
Sulphide Corporation (15s.)	11 3	12 6
Zinc Corporation (10s.)	8 9	13 0
ASIA:		
Burma Corporation (10 rupees)	6 3	7 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	6 0	5 9
TIN:		
Aramayo Mines, Bolivia	1 7 6	2 6 3
Bisichi (10s.), Nigeria	5 9	5 6
Briseis, Tasmania	2 6	3 6
Chenderiang, Malay	11 3	11 3
Dolcoath, Cornwall	9	9
East Pool (5s.), Cornwall	3 6	2 9
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 6
Geevor (10s.), Cornwall	2 6	3 6
Gopeng, Malay	1 12 6	1 13 9
Ipoh Dredging, Malay	10 0	7 6
Kamunting, Malay	1 3 9	16 3
Kinta, Malay	1 12 6	1 12 6
Lahat, Malay	10 0	6 3
Malayan Tin Dredging, Malay	1 5 0	1 2 6
Mongu (10s.), Nigeria	11 3	8 9
Naraguta, Nigeria	15 0	12 6
N. N. Bauchi, Nigeria (10s.)	2 0	2 0
Pahang Consolidated (5s.), Malay	5 6	5 0
Rayfield, Nigeria	3 0	2 0
Renong Dredging, Siam	1 5 0	18 9
Ropp (4s.), Nigeria	6 0	5 6
Siamese Tin, Siam	1 17 6	1 12 6
South Crofty (5s.), Cornwall	4 6	4 6
Tehidy Minerals, Cornwall	6 3	7 6
Tekka, Malay	17 6	15 0
Tekka-Taiping, Malay	1 1 3	17 6
Tronoh, Malay	1 6 0	1 8 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

LEAD AND ZINC MINING IN THE LAKE DISTRICT.

Vol. 22 of the Special Reports on the Mineral Resources of Great Britain, prepared by Tom Eastwood, A.R.C.S., for the Geological Survey, deals with the lead and zinc ores of Cumberland, Westmorland, and North Lancashire. It may be mentioned here that this district was the subject of a Memoir of the Geological Survey by J. Clifton Ward, published in 1876; and that much valuable information is also contained in Postlethwaite's *Mines and Mining in the Lake District*, published in 1913. We quote at some length from Mr. Eastwood's report, and in doing so it is desirable to record that since his report was written the mines were all closed, owing to reasons already explained in our columns, but that more recently the lead-producing mines have been reopened. Further information on this matter is given in our Editorial columns.

The Minerals and Lodes.—The English Lake District, a mountain group that falls within the counties of Cumberland, Westmorland, and Lancashire (Furness), has been well mineralized, but although there are innumerable veins carrying ore of some kind, the number that can be considered productive under modern conditions is comparatively small. Mining has been carried on sporadically for hundreds of years. As a copper-producer, the district had an excellent reputation in Elizabethan times, and was of considerable importance. The output of lead, and still more of zinc ores, is of more recent date.

Lead ores are found in three main regions: (1) Keswick, (2) Helvellyn, (3) Caldbeck Fells. In the Keswick field the veins traverse folded shales and mudstones interbedded with thin sandstones. These strata belong to the Skiddaw Series, and are of Cambro-Ordovician age. In the Helvellyn area there is a country rock of volcanic ashes, tuffs, and breccias, interstratified with lava flows and pierced by numerous igneous intrusions. These belong to the Borrowdale Series, are exclusively Ordovician, and are younger than the Skiddaw Series. In the Caldbeck Fells, Borrowdale volcanic rocks again predominate; they are of more basic type than usual, and are known as the Eycott Series. At the Drygill mine, a set of fossiliferous shales and mudstones with bands of lava are now regarded as of late Ordovician (Bala) age, belonging to the Coniston Limestone Group. In no other locality in the Lake District do the Bala strata contain workable veins, and the veins in the still younger (Upper Silurian) Bannisdale Slates, on the south side of the lake country, have so far proved unproductive. In addition to the sedimentary rocks, there are igneous intrusions (the Skiddaw Granite on the north side of the Keswick field, and gabbro, hypersthenite, felsite, etc., in the Caldbeck Fells) all traversed by metalliferous veins. It is possible that the richness and the variety of the ores in the Caldbeck Fells may have some connexion with the multiplicity of rock types found there.

A few of the quartz veins and strings profusely scattered over the Lake District originated before the crumpling movements had ceased, but the great majority of the veins are of later date and unaffected. In the latter category the metalliferous veins are included; most of them are essentially fault-breccias, impregnated with vein-quartz and gangue spars, accompanied by ores of lead, zinc, and copper. They are classified locally as lead or copper veins, according to the dominant mineral. In some of the so-called lead veins, zinc blende is in reality the principal ore, but it is only in comparatively recent times that the value of this mineral has been recognized. In all the fields there is a general rule (subject, however, to many exceptions) that veins carrying ores of lead and zinc range within 45° on either side of a north-and-south direction, and hade to the east, while copper-veins trend more nearly east-and-west, hading south.

The chief lead ore is galena. It is markedly argentiferous, and the silver content appears to have some relation to the presence of barytes; veins with little or no barytes (Thornthwaite, Threlkeld, and Greenside) are low in silver (about 10 oz. per ton of pig lead), while in barytes-galena veins, such as Force Crag and Driggith-Sandbeds, the silver content is always high, in fact seldom less than 30 oz. to the ton. This coincidence seems worthy of attention, although it may well be purely fortuitous. Lead ores, other than galena, are unimportant; some cerussite ($Pb\ CO_3$), and pyromorphite ($(PbCl)Pb_4(PO_4)_3$), mimetite ($(PbCl)Pb_4(AsO_4)_3$), and kampylite (a mixture of pyromorphite and mimetite) have been got from the superficial parts of the lodes; anglesite ($PbSO_4$) is rare; stolzite ($PbWO_4$) is found only at Force Crag.

The only zinc ore of commercial importance is blende; occasionally specimens of calamine ($ZnCO_3$) and hemimorphite ($(ZnOH)_2SiO_3$) have been got at Roughtongill in the Caldbeck Fells.

Copper ores, while mainly developed in the so-called copper veins, frequently occur in lead veins also, though such cases are of economic value in the Caldbeck region only. They are represented by chalcopyrite, and its various coloured alteration products (malachite, etc.).

There is a certain amount of iron pyrites in most of the veins; as a rule, it is not in sufficient quantity to interfere with dressing operations, though in the deeper levels of Threlkeld mine it gave trouble. Limonite is not uncommon; chalybite is occasionally seen. Manganese occurs as psilomelane, coating other minerals near the outcrop of a vein.

The chief gangue mineral, everywhere, is quartz; it may be hard and platy; sometimes it is sugary or like fine sand. The spars are relatively unimportant; barytes is of sporadic occurrence, being usually found in the upper levels of certain veins as at Force Crag. Calcite is rather rare; the chief locality is Roughtongill (Caldbeck Fells),

though it is seen at times at Greenside mine. Dolomite (Force Crag, Thornthwaite, etc.) is more common, though nowhere plentiful. Fluor-spar, so often associated with lead veins elsewhere, is exceedingly rare in the Lake District; a few small crystals were got recently at Force Crag.

As regards order of crystallization, the minerals may be arranged in pairs; in each, one member may or may not precede the other. The couple galena-blende usually precedes barytes-dolomite, while iron pyrites and psilomelane appear last of all. The copper ores are less regular; in the Keswick field chalcopyrite usually precedes galena-blende, but (so far as one can see from fragments on the waste-heaps) the reverse often holds along the Roughtongill-Driggith lode in the Caldbeck Fells. Quartz, in all the fields, may belong to any period of crystallization.

Both the richness and the character of the lodes are associated with various factors whose influence is little understood. In many veins it has been noticed that an increase in steepness coincides with enrichment, and vice versâ. The hardness and chemical composition of the country rock both have their effect. As a rule, moderately hard rocks are better ore-bearers than soft ones, and in very soft rocks the lode is often barren. At Coniston, however, constriction and impoverishment occur in hard hornstones as well as in slate.

Changes of composition in the country have a special significance in the igneous complex of Caldbeck Fells. Acid rocks, such as the quartz-felsite dyke at the north end of Greenside mine, deaden the veins completely. Sub-basic types (for example, the dykes at Threlkeld and Brandlehow), and in a still greater degree the basic rocks such as the hypersthene gabbro of Roughtongill, seem to favour the enrichment of the veins that traverse them.

As regards the effects of depth on the ore-bodies, mining in the Lake District is on too small a scale to permit of an extended series of observations. The veins, as a rule, do not bear well much below the main valleys; although there may be rich "sops," the ore-bodies generally dwindle and the barren tracts increase with depth. Thornthwaite vein, however, is an exception to this rule, and Greenside lode, though not yet wrought below the level of the main valley, shows no sign of deterioration. Depth not only affects the general productivity of a vein, but (in at least one case) it also has a marked influence on the distribution of the minerals. At Force Crag barytes and psilomelane are prominent in the higher levels, while lower down, blende and galena prevail, the former increasing in the bottom levels. At Thornthwaite, the silver content of the galena increases slightly in depth.

In common with other regions, enrichment often occurs at the intersection of veins; a dissimilarity in the lodes appears to favour this, an excellent illustration being the discovery of the Great Lead Bunch at the intersection of the Goldscope lead and copper veins.

Although there is evidence as to the relative ages of the various groups of veins, no definite dates can be given. The extension of some of the fault lodes into Carboniferous Limestone strata suggests that they are at least post-Carboniferous, and this is also Dr. Harker's opinion regarding the faults displacing the gabbro at Roughtongill. Analogy with similar rocks in the west of Scotland has led J. E. Marr to suggest a Tertiary age for the complex of Carrock Fell, which is cut by several of the lodes. J. F. N. Green, on the other hand, maintains that the igneous rocks of Carrock are pre-Bala in age. The whole question is complicated by the fact that much of the vein contents may be later than the faults along which they occur. The only definite statement possible is that there are at least two, and perhaps three, periods of mineralization. Examples are given later in the paper from the Keswick region, showing an east-and-west copper lode displaced by a north-and-south lead vein, and from the Caldbeck Fells showing an east-and-west lead-copper vein shifted by north-and-south faults, which carry tungsten farther south; in the third, from the Helvellyn region, the barren east-and-west cross-courses which shift the north-and-south lead vein at Greenside may belong to a third and final period.

Mining.—Lead-mining in the Lake District has passed through many vicissitudes, and the only mines in operation at the time of Mr. Eastward's examination (see introductory note) were those of Greenside, Thornthwaite, Force Crag, and Threlkeld. Brundholme was not then fully opened out; at Goldscope or Newlands, the old level was being pushed forward to endeavour to locate the intersection of the copper vein with Sealby's lead vein, in the hope of proving a galena bunch. The other mines, now closed for a variety of reasons, are described by Mr. Eastwood. Some, perhaps, are exhausted, while others were of little value from the start; but in many cases the reason for failure appears to have been lack of capital, sufficient money being subscribed to start a mine in a small way provided that fairly good ore, requiring no elaborate dressing, was found almost immediately. Even when good ore-bodies were found, prospecting for others did not proceed along with development.

The remote situations of most of the mines raise serious transport difficulties, the working cost being especially affected where coal is the power generator. Electricity derived from water power is used at Greenside, but most of the other mines are not so favourably situated in this respect. There is a fair local supply at Roughtongill, while a larger body of water, though with less fall, can be got from the Caldew.

Ore-treatment in the Lake District is usually along normal lines, calling for no special remark; attention may be drawn, however, to the successful separation of blende from barytes at Force Crag, by means of the Elmore flotation process. Some of the mines in the Caldbeck Fells—such as Drygill, Driggith, and Sandbed—have had difficulty in obtaining, locally, sufficient water for dressing, and in the past were linked up by a system of leats gathering water from springs and streamlets on the intervening hillsides. If the mines were reopened on a modern scale, this system of leats would have to be considerably enlarged, or dressing carried out at lower elevations, where water is more abundant.

Smelting and desilverizing are no longer carried out locally, the last work of this kind, at Greenside, having closed down during the war.

The Mines.—As already mentioned, the only mines working when Mr. Eastwood made his examination were Thornthwaite, Threlkeld, Greenside, Brundholme, Force Crag, and Goldscope. He has also reported on the following properties: Keswick Field, Barrow, Stonycroft, Yewthwaite,

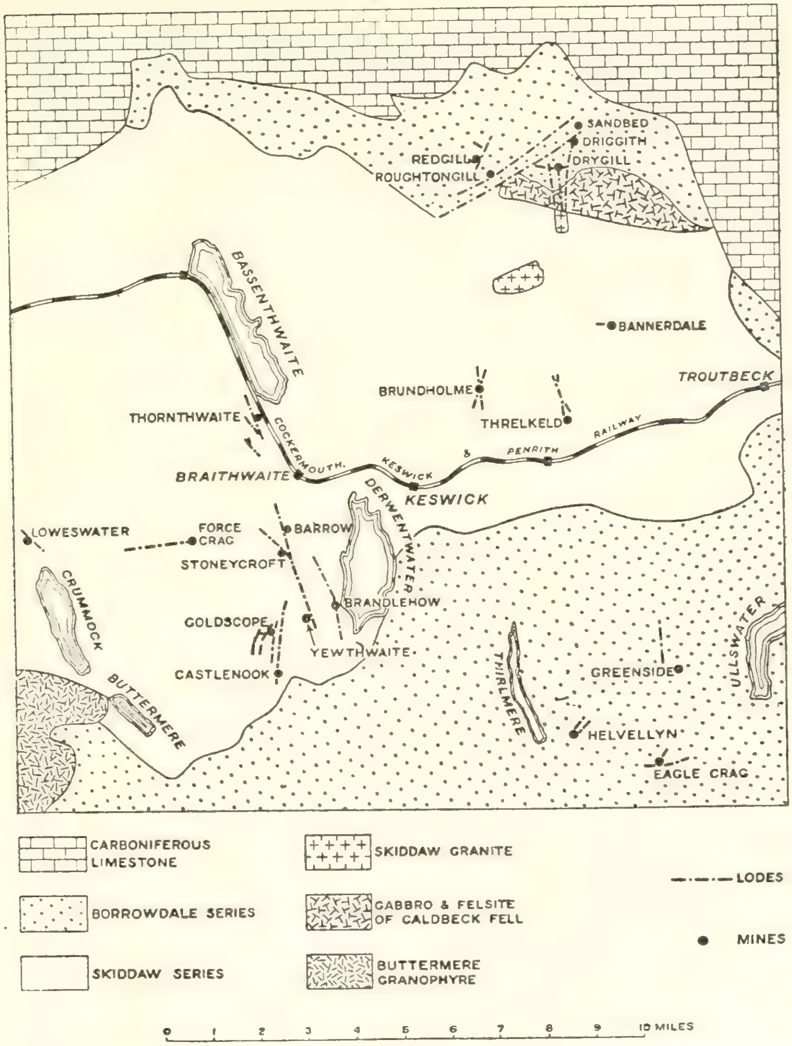


FIG. 1.—GEOLOGICAL SKETCH MAP OF THE LAKE DISTRICT SHOWING DISTRIBUTION OF THE LEAD AND ZINC MINES.

and Castle Nook, all in the Vale of Newlands; Brandlehow or Brandley, on Derwentwater; Saddleback, Bannerdale, etc., on Skiddaw. On Caldbeck Fells: Roughtongill, Redgill, Drygill, Driggith, Sandbed, etc. On Helvellyn: Grisedale, Hartsop Hall, Wythburn, and Low Hartsop. Scattered occurrences: Loweswater, Windermere, and Coniston.

Thornthwaite.—These mines are situated at the south-western end of Bassenthwaite Lake, close to Thornthwaite village. On this property, within an area about $1\frac{1}{2}$ miles long and $\frac{1}{2}$ mile broad, there are at least four veins. They all trend in a general N.N.W. direction, through contorted Skiddaw Slates, and taken in order from E. to W. are known as the Thornthwaite (the principal lode), Rachel, and East and West Ladstock veins. The old Beckstone mine, at the northern end of the area, is isolated from the rest, and may possibly have wrought extensions of the Rachel lode.

There were four distinct mines, from which sufficient ore was raised for a local smelting works, which remained in operation until 1849. Ladstock is the oldest and began in the pre-gunpowder days of mining, though Beckstone and the crop workings of Rachel Wood are also very old. The outcrop of the Thornthwaite lode being on low-lying ground, the vein could not be attacked by adit, but required a shaft, which was 27 fm. deep in the early days of last century. In 1848 the Keswick Mining Co. reopened Thornthwaite mine, and treated the old dumps of Beckstone, but operations did not extend beyond five or six years. In 1873 W. Francis took over the mines and reopened Ladstock. The Keswick United Silver Lead Mine Co. was next formed, and Thornthwaite was reopened. In 1875 the Rachel Wood cross-cut was commenced, but abandoned before reaching the veins. J. B. Lobb took over the property in 1881, under the title of The Cumberland Lead Mine Co. The shaft was

deepened to 50 fm., and a more efficient plant erected. After the death of Mr. Lobb, the mine was transferred to the present proprietors—Thornthwaite Mines, Ltd.—under the direction of F. C. Crewdson and Anthony Wilson, who have pushed forward the abandoned Rachel Wood cross-cut and developed the mine considerably.

The country of the mining belt consists of dark sandstones and shales, partly cleaved, highly contorted and probably smashed by numerous faults of small throw. It is everywhere traversed by small irregular strings of quartz, though these are not regarded as feeders by Messrs. Wilson and Turner. J. Postlethwaite mentions " thin dykes or sheets of intrusive trap (diorite ?) which intersect, and no doubt enrich the veins," but, so far as is known, the only igneous rock seen in the field is the narrow dyke of dolerite running from N.E. to S.W., through the higher part of Rachel Wood, and this has not yet been located in the mine. The Thornthwaite lode (believed to be a northerly continuation of the Barrow-Yewthwaite vein) lies immediately west of the main road on the S.W. side of Bassenthwaite Lake. It inclines eastward at about 24° from the vertical. The hanging wall is usually well defined and is frequently covered with " douk "—soft blue clayey matter—from 0 to 10 ft. in thickness. The foot-wall is ill-defined or absent, mineral matter usually dying out in this direction as the foot-country flattens. The vein-filling is mainly smashed rock similar to the country, with, as a rule, but little quartz. This renders the vein troublesome to follow and locate when barren. Owing to the peculiar nature of the vein, it is difficult to estimate its average breadth. In the 65 and 85-fm. levels, south of the shaft, the space between the hanging wall and the western limit of ore-bearing ground may be as much as 50 ft., and is frequently 20 to 30 ft. across. At such " swells " the hanging wall, instead of hading to the east, inclines westward, and the stoping-ground is in two portions, with a barren tract in the middle of the vein. The vein is stated to have been very gossany near the top.

The chief gangue mineral is quartz ; it occurs in irregular strings and forms but a small percentage of the vein-filling, though occasionally (as in a stope above the 85-fm. level, north of the shaft) it is locally abundant and makes up the bulk of the vein. Dolomite, mixed with some pyrites, and forming cavernous masses, is met with in the 85-fm. level south. It is spoken of as " burnt-up ground," from its rough clinker-like appearance, but does not seem to be associated with barrenness in the vein as a whole, though some of the pyrites may be pseudomorphous after galena. Pyrites, nowhere abundant, is not restricted to any portion of the vein, although it may be a little more common in the deeper parts of the mine.

The ores obtained are of lead and zinc in the proportion of 1 to 2. Galena is the only lead ore now raised, but cerussite is said to have been fairly abundant in the upper levels. The silver content, averaging about 10 oz. of silver per ton of pig lead, shows a slight increase with depth ; thus prior to 1915, it was a little above 10 oz., while in 1918, the average was 10·97 oz. per ton (by fire assay in both cases). Galena as a rule occurs in ribs, especially towards the hanging wall ; small bunches are occasionally found in the " douk." Towards the foot-wall these ribs are rare, thin, and irregular, small splashes being commoner. Most of the blende, on the contrary, is found towards the foot-wall, and not in ribs, but scattered through the veinstuff. There was an exception to this rule in a stope midway along the 85-fm. level south of the shaft, where the hanging-side showed a rib of blende about 4 in. thick and some yards in length, between two thin bands of quartz, followed by two ribs of galena about 6 in. in thickness. These ribs of ore are not constant in relation to the hanging wall, but swing across the vein in an irregular manner.

Little is known about the Rachel Vein, which, unlike the others, hades to the west, where it was originally worked along the outcrop on the steep slopes of Rachel Wood. In the bottom of the wood, behind Walkergate, a cross-cut was begun some years ago, which, after passing a barren vein, struck the Francis and Rachel Lodes, 10 to 20 yards apart, about 180 yards in. Ore was got from both veins over a length of 45 fm., the Rachel Vein being the better of the two. Continuations of the levels at both ends proved fruitless ; on the north, though feeble slips may occur, this barrenness seems to be due to the vein dying out. Southwards, heavy broken ground was encountered, which suggests faulting, but the vein has not yet been picked up. The cross-cut was continued westward without proving ore in bulk. Some thin quartz strings and a feeder of ferruginous water at 247 yd. from the entrance may represent the East Ladstock Lode. At the far end (about 474 yd. from the entrance) broken ground, 40 ft. wide and requiring heavy timber, was cut through. Some of the " rushed-stuff," of clay and slaty material, shows a small quantity of blende and galena and may therefore represent the West Ladstock Lode in a shattered condition. At the present time development is suspended at this point.

The East and West Ladstock Veins, referred to above, lie at the south end of the mining field, and west of the Rachel Lode. They were exploited on a small scale at the old Ladstock mine near the wood of the same name, and on the south side of Comb Beck. At the beck, these veins are about 100 yd. apart, but are believed to unite about 150 yd. farther south. Northwards they cannot be traced at the surface through the west side of Rachel Wood, but, as already pointed out, may be represented in the Rachel Wood cross-cut. By Comb Beck there are open stopes with levels on the two lodes, from which the veins seem to have been from 2 to 4 ft. wide, with a slight hade to the east. On the hill is an old shaft, now filled up. The dumps are small, consisting mainly of Skiddaw Slate with a little quartz and blende. Galena was the ore raised.

The old Beckstone mine, abandoned about 1830, lies north of Thornthwaite. A little galena was got here, from a vein which may be a northerly continuation of the Rachel Lode ; the hade is not known, nor is there much information of any kind as to the workings. A cross-cut adit opening between Beckstones and the high road (marked as a well on the 6 in. map) is still partly open, but a day-level below the Bishop rock, apparently on the vein, is blocked up at the entrance ; several bell-pits and shafts may be seen on the south side of the stream.

The proved ground on Thornthwaite Vein is about 320 yd. long, a shaft being sunk about midway, and levels driven off north and south along the vein at depths of 17, 27, 37, 47, 65, and 85 fm. The present limits of the ore-bearing ground

are somewhat peculiar. The 85-fm. level south ends against a blank wall with stringers of galena along it to the west. This was cut through and followed west for some yards, but the driving failed to locate the vein. The 65-fm. level south encountered a similar wall, an examination of which showed the usual contorted alternation of " stony " and slaty bands, but none of the broken ground usually associated with faulting, though small slips may have occurred between sandstones and slates. In the 47-fm. level south, the vein was also lost, but the level was continued southwards with short cross-cuts at intervals. To the east some of these penetrate the " soft blue " or " douk " on a smooth face similar to that of the hanging wall. At the extreme south of the level thin quartz strings were encountered, and though no galena was seen the vein appears to be re-forming. Once lost, Thornthwaite is certainly not an easy vein to find again, but in other respects presents no special mining difficulties.

The ore is raised at the shaft to about 16 ft. above the surface, and tipped to an incline for rough picking, before passing to two Marsden stone-breakers and a set of crushing rolls. The material is then sized by trommel and elevated to the jigs. The rejects from the jigs pass to a ball-mill. The fines are treated on tables (three Deisters and five Wilfleys) and the slimes on a Luhrig vanner. The effluent from the dressing-floors passes into Bassenthwaite Lake. To prevent contamination an efficient and nearly automatic pair of large slime-settling pits, covering 2 acres or more, have been designed and laid down by Mr. Wilson on the gently sloping fields between the mine and the railway. They consist of a double wall (made of turf and tailings) with pipes at intervals leading through the inner wall at the lower end into the central enclosed settling-area. The coarser material is deposited in the channel between the double walls, and is partially removed at intervals to raise the walls and embankments. The finer material passes through the pipes into the central settling-area, and gradually builds up deltas, and as these grow and extend the pipes are inserted at higher levels in the growing walls. The effluent from the settlers is taken at the higher side of the pits and conducted to the lake. The deltas form natural buddles and show any ore leakages, however small, from the dressing plant. There is a steam winding plant, but water-power is used for pumping and is aided by suction-gas engines for driving the crushing and dressing plant as well as the air compressor for the seven rock-drills in use in the mine.

From about 1870 up to the end of 1918 the total output of blende was 15,682 tons, valued at £90,673, and of galena 10,987 tons, valued at £111,515 ; the average price of galena during that period being £10 3s., and of blende £5 15s. 5d. per ton. The proportion of galena to blende has decreased of late years ; for the whole period 1870–1918 galena formed 41·2% of the total output, while in the years from 1870 to 1900 it was 51%. In 1918, by fire assay, the galena averaged 81·36% of lead, and blende 49·7% of zinc. During 1919 the zinc in the blende has risen to above 50%. Galena is usually dressed to an 81% concentration.

(*To be continued.*)

THE BOSTON-SKEAD GOLD AREA, ONTARIO.

The Boston Creek district and the Skead district close by are to the south of Kirkland Lake, and are attractive to prospectors. Though no important producer has as yet been developed, and though things look rather dead at present, it is generally agreed that the area is favourable for gold discoveries. For this reason we quote at some length from a new report prepared for the Ontario Geological Survey by A. G. Burrows and P. E. Hopkins.

Claims were staked for gold in this area in 1906 and 1907, during the days of the Larder Lake gold rush. Again, in 1913, during the activity at Kirkland Lake, 12 miles to the north-west, many claims were restaked and some work was done on them. Since May, 1915, following operations on the R. A. P. and Boston Creek gold mines, there has been considerable activity from year to year. A small amount of bullion has been produced at the Patricia and Miller-Independence mines, but no steady gold producers have been developed.

The first exploration was by Walter McOuat, who, in 1872, made a reconnaissance survey of the Blanche River from Lake Timiskaming to Round Lake. W. G. Miller, Provincial Geologist, in 1900 described a portion of the area. In his report the geology along the Blanche River in McElroy and Catharine townships is described. He also mentions prospecting for gold on a 4 ft. quartz vein in the hill west of the lower end of a portage in Catharine township. In 1904, after the discovery of Cobalt, W. A. Parks, of the University of Toronto, made a geological survey of this portion of the country. Parks remarks that the high hills along the Blanche, in the township of Catharine, are well worth prospecting for gold. In 1908 and 1909 M. E. Wilson examined the Larder Lake gold area, which is located to the north-east of Boston Creek. The geological map accompanying his report takes in Skead township.

The area in general has an elevation varying from 700 to 1,050 ft. above sea-level. Boston Creek station has an elevation of 920 ft. While the difference in elevation is seldom more than 200 ft., the country is somewhat rugged and broken, particularly in the vicinity of Boston Creek station and along the north branch of the Blanche River in McElroy and Catharine townships. The country is situated south of the continental divide, and is drained by three branches of the Blanche River and their tributaries which flow southward into Lake Timiskaming.

The rocks of the area are of pre-Cambrian age. The dominant formations are members of the Keewatin, while formations of later age occur in relatively minor quantity, with the exception of a batholith of Algoman granite, which covers the greater part of Pacaud township, and areas of conglomerate and greywacké of the Cobalt series in the east and south parts of Skead township. The intrusive rocks, including granite and porphyry, which are believed to be associated with the gold mineralization, occur in small masses or narrow dykes through the older rocks. The table on the succeeding page gives the general geological structure of the region.

PLEISTOCENE.	
Glacial and Recent.	Boulder clay, sand, and gravel.
PRE-CAMBRIAN.	
Keweenawan.	Quartz diabase, olivine diabase.
	Intrusive Contact
Animikean. (Cobalt Series)	Conglomerate, greywacké, quartzite.
	Unconformity.
Algoman.	Hornblende and biotite granite, syenite, felspar-porphyry, quartz porphyry, lamprophyre.
	Intrusive Contact.
Haileyburian.	Serpentine.
	Intrusive Contact.
Timiskamian (?)	Schistose conglomerate, greywacké, slate.
	Unconformity.
Keewatin.	Grey schist (volcanic fragmental), ellipsoidal, amygdaloidal, and spherulitic lavas, diabase (in part altered to hornblende and chloritic schist), felsite, andesite, dacite, iron formation, rusty weathering carbonate.

As pointed out by W. G. Miller and C. W. Knight in a paper entitled "Metallogenetic Epochs in the Pre-Cambrian of Ontario," published in 1915 by the Ontario Bureau of Mines, most of the gold deposits of Ontario belong to the Algoman epoch. The gold deposits of Boston Creek supply another example of gold being derived from acid intrusives of Algoman age. The granite, syenite, and felspar-porphyry exposed in this area by erosion are probably different facies of a plutonic rock which underlies the whole area. The gold generally occurs near these acid rocks. The presence of a number of gold-bearing veins along the contact of the intrusive porphyry and older rocks at Boston Creek, as in many other parts of central Canada, and the frequent occurrence of auriferous quartz veinlets in the porphyry and granite, suggest the relationship between the intrusives and the veins. The deposits are in part due to the replacement of the country rock by mineral solution. Only a few minerals which characterize deposits that are formed at high temperatures are found in the veins at Boston Creek. It is probable that the deposits were formed at great depth, but not at extremely high temperature.

Gold, the chief mineral sought for in the area at the present time, occurs, usually native, but occasionally combined with tellurium, in quartz veins and veinlets in the Keewatin greenstone and later intrusions of granite and porphyry. The veins, which have various strikes and dips, are well mineralized with varying quantities of pyrite and molybdenite, and sometimes with chalcopyrite, galena, specular hematite, cosalite, native bismuth, gold, and tellurides. The gangue consists largely of quartz of several generations, with considerable calcite and chlorite. The gold is found along the dark streaks of chlorite and calcite.

There are many types of gold deposits, namely :—

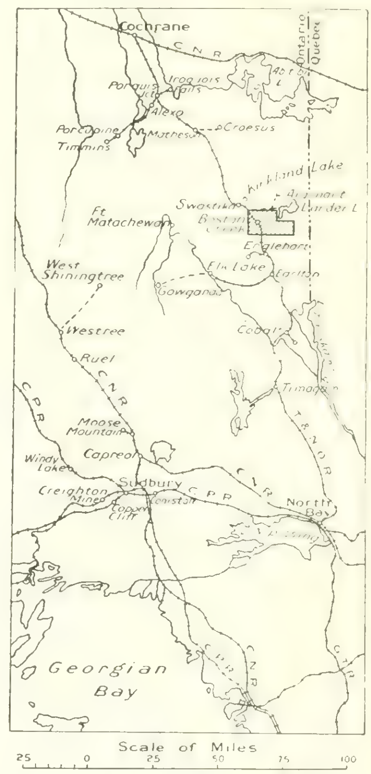
(*a*) Fissure quartz veins in the greenstone, granite, and porphyry, with well-defined walls. Examples : No. 1 vein at Miller-Independence, Boston-McCrae, Authier, Patricia, and Wisconsin-Skead.

(*b*) Replacement veins. The country rock, including altered greenstone and porphyry, has been brecciated and partly replaced by vein-forming solutions of quartz of several generations, and by calcite and other carbonates. Examples : the calaverite vein on the Miller-Independence and the Kenzie vein on the R. A. P. property.

(*c*) A stockwork in granite and porphyry. Examples : Charest, Authier, and Papassimakes.

The authors proceed to give details of operations at the various workings, the position of which are shown on the accompanying map. Particulars of some of the most important workings are quoted herewith.

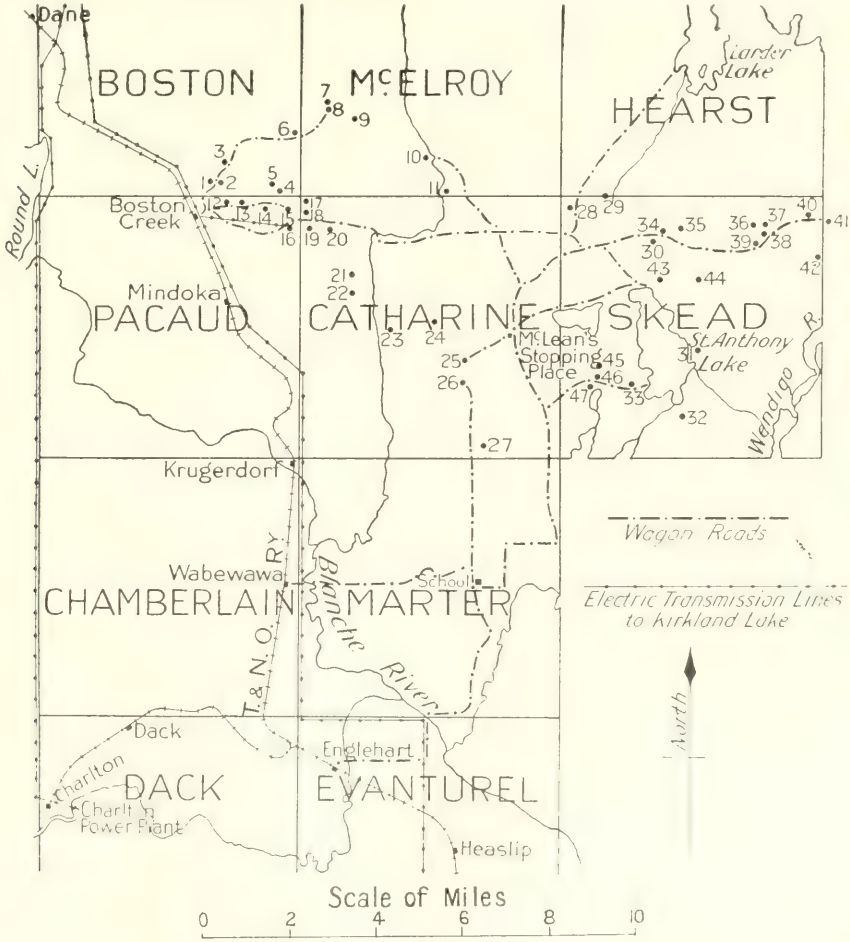
R. A. P.—The first discovery of gold in Boston Creek was made in 1914 in the Kenzie vein, in the south central part of Boston township. During that year some work was done on the vein by the La Rose Mines, Ltd. During 1916 the R. A. P. Syndicate, controlled by E. M. Richardson, W. B. Albright, and J. K. Papassimakes, continued development on the Kenzie vein. The inclined shaft was sunk to the 200 ft. level, and driving done as follows : On the 100 ft. level, east drift 250 ft.,



west drift 175 ft. ; 200 ft. level, east drift 90 ft., west drift 190 ft. Development has shown the ore to occur in small shoots in the vein. The vein strikes 30° north of east, and dips 65° S. in massive pillow lava. The vein varies from several inches up to 5 ft. in width with good breaking walls on either side. The vein material consists of quartz of several generations, silicified rock, reddish calcite, and brecciated and partly replaced masses of reddish felspar-porphyry. The occurrence of felspar-porphyry in various parts of the workings suggests that originally the greenstone was intruded by a narrow felspar-porphyry dyke, which at a later period was greatly brecciated and impregnated with vein-forming solutions carrying the gold and other minerals. The gold occurs with a very fine-grained greenish quartz, which has the character of a replacement deposit, while the green colour is due to minute inclusions of chlorite. Iron pyrites is finely disseminated in the vein, and copper pyrites, molybdenite, and galena occur in minor quantity.

Thin sections of the ore show the gold to be closely associated with the sulphides in chlorite and calcite seams near the foot-wall part of the vein, where there is a narrow band of fine-grained greenish quartz. Certain sections of the vein run as high as $25 or $30 in gold to the ton, across 5 ft. To the north-east there is an irregular band of mineralized schist with quartz, about 1 ft. wide,

Boston Creek.—The Boston Creek Mining Co., Ltd., did considerable development work on claim L. 3665 in Boston township during the year 1916. Work was carried on through the R. A. P. shaft, which was rented with hoisting equipment from the R. A. P. Syndicate, as mentioned above. The drifts on the 100 and 200 ft. levels of the R. A. P. were extended into the Boston Creek ground and a



THE BOSTON-SKEAD AREA.

References to Properties: 1, Boston Creek; 2, R. A. P.; 3, Currie; 4, Authier; 5, Ivanhoe-Boston; 6, Gold Leaf; 7, Hughes-McElroy; 8. Peerless or Mondoux; 9, Charest; 10, Marsh; 11, Irish; 12, O'Donald; 13, Patricia or Barry-Hollinger; 14, Boston McCrea; 15, Allied Gold; 16, Miller Independence; 17, Campbell; 18, Cotter; 19, Connell-McDonough; 20, Kennedy-Boston; 21, Burnand-Gzowski; 22, Catharine Gold; 23, Ostrum; 24, Daley; 25, Walsh-Taylor; 26, Roger-Barnett; 27, Hounslow; 28, Zenith Gold; 29, Cook; 30–3, Flanagan; 34, Lincoln-Nipissing; 35, Manley-O'Reilly; 36, Martin; 37, Sampson; 38, Wisconsin-Skead; 39, Crawford-Skead; 40–1, De Villiers; 42, Mageau-Authier; 43, Fidelity; 44, Barry Webster; 45, Nigger; 46, Skead Gold; 47, Telluride Syndicate.

which contains visible gold. The showing occurs where the greenstone is intruded by a dyke of felspar-porphyry, and near the contact. Work was discontinued by the syndicate on September 17, 1916, and the shaft and hoisting equipment were rented to the Boston Creek Mining Company. In July, 1917, preparations were under way to take over the shaft and resume work.

rise carried to the surface from the 200 ft. level. A winze has been sunk 200 ft. from the 200 ft. level, and stations cut at the 300 and 400 ft. levels. Development is as follows: 100 ft. level, 325 ft. of driving and cross-cutting; 200 ft. level, 300 ft. of driving and cross-cutting; 300 ft. level, 50 ft. of driving and cross-cutting; 400 ft. level, 300 ft. of driving and cross-cutting. The vein is a con-

tinuation of the Kenzie vein from the R. A. P., and similar in appearance. Spectacular gold showings were obtained in the upper 30 ft. of the shaft, and a few very small shoots were obtained in the deeper levels. In February and March, 1917, new buildings were erected, including office, sleeping camps, dining-room, and store-house. Operations were suspended in July, 1917, to permit of exploration by diamond-drilling.

Patricia.—The Patricia (Barry-Hollinger) consists of two claims in Pacaud township. A mining and milling plant was placed on the property and the mine was operated for a short time in 1917 and 1918 by the late C. A. O'Connell. A forest fire in July, 1919, burned the mine buildings and mill, the mine not being in operation at the time. Twelve veins were found on the property, but underground operations were chiefly confined to vein No. 7, with a small amount of work on a parallel vein to the north. An inclined shaft was sunk 215 ft. on No. 7 vein, that dips 74° S. with ore-pockets at the 100 and 200 ft. levels and drifts along the vein on these levels. Two stopes, 25 ft. and 130 ft. in length, were opened up on the 100 ft. level in the west drift, and one stope 80 ft. long on the 200 ft. level. The stopes were carried up about 30 ft. before milling operations were suspended. The ore is banded quartz of rather fine grain and carries a small percentage of iron pyrites, and some copper pyrites and zinc blende ; it frequently shows native gold in hand specimens. The quartz varies in width from about 12 to 30 in. In the west drifts on the two levels, bands or lenses of calcite were encountered with a narrowing of the quartz. The values are contained in the quartz vein with little mineralization of the enclosing basic rock. The ore raised from the mine was of good grade, approximately $18 per ton.

Miller Independence.—This property, which is one of two in the area which has produced some gold, is situated in Pacaud township. Gold was first discovered by Joseph McDonough in July, 1915. Three years later W. Adams, then mine captain, discovered the Independence Vein, which contains a small shoot of ore carrying a precious telluride, calaverite. All the recent work has been done in connexion with this vein. The geology is comprised dominantly of alternating flows of Keewatin pillow lava (meta-basalt), altered diabase or dacite, with which are associated subordinate amounts of rhyolitic schists, agglomerate, iron-formation, and tuffs, all of which have a N.W.-S.E. trend. These rocks are cut by small granite stocks and felspar-porphyry dykes. In the vicinity of the veins the rocks contain abundant calcium, magnesium, and iron carbonates. The original No. 1 vein has been traced on the property for about 600 ft. in an east and west direction and for several hundred feet easterly into Catharine township. It is narrow, averaging about a foot in width, and has a low dip to the north, usually about 20° or less, at one place being almost horizontal. The vein material is milky white quartz, and the mineralization is more or less concentrated toward the foot-wall side of the vein. Tellurides, copper pyrites, pyrite, specular iron ore, and galena are observed in the quartz. Native gold occurs frequently with the telluride in a net-like arrangement in the quartz along the foot-wall. A bismuth telluride, brilliant grey in colour, and containing some selenium, occurs abundantly with the gold. A darker-coloured telluride (petzite?) is also present in smaller amounts. The vein has been prospected by means of a number of trenches, pits, and shafts from which some high-grade ore was bagged and a small production recorded. Along parts of both walls of the vein there is a narrow dyke of grey felspar-porphyry. The porphyry contains much calcite and other carbonates, as well as disseminated iron pyrites, and is cut by veinlets of quartz. The Independence vein, containing the small shoot of exceptionally high-grade ore, strikes 22° E., and dips 55° south-easterly. The rich ore was found between the depths 30 ft. and 160 ft. in the inclined shaft, but could not be traced for any great distance on the 100 ft. level. The hanging wall of the shaft is a strong fault plane. Below this is a second fault plane nearly parallel to the upper one, the planes varying from 1 to 3 ft. apart. Below the lower fault plane is a series of irregular quartz veinlets from a fraction of an inch to one inch in width and roughly parallel to the fault plane. A few veins are terminated sharply at the fault plane, indicating that some of the faulting is later than the mineralization. About 10 ft. above the 100 ft. level the veinlets occur over a width of 4 ft. These veinlets can be followed down to 160 ft. in the shaft, below which the rock is less altered. Where the veinlets occur, the dark basalt has been altered for a few inches to a light grey rock, carrying abundant iron pyrites. The quartz carries in places iron pyrites and copper pyrites, together with gold telluride, calaverite. The telluride occurs chiefly in minute veinlets and small masses in and with the copper pyrites, and is sometimes accompanied by native gold. Faulted sections of flat-lying quartz veins were observed between the main fault planes about 50 ft. below the 100 ft. level. Shaft "A" has been sunk vertically to a depth of 500 ft. and extensive exploration carried on at this level. The strong faults on which the inclined shaft "D" was sunk to the 200 ft. level were encountered on the cross-cut on the 500 ft. level, 190 ft. north of "A" shaft ; driving along these faults did not reveal any ore of similar character to the rich telluride ore which was found in "D" shaft. Seven diamond-drill holes were made from the 500 ft. level.

Peerless.—The Peerless property comprises a group of claims, formerly the Mondoux, in the west part of McElroy township. The rocks are principally of Keewatin age and are intruded by small masses and dykes of granite. Work has been largely confined to a strong quartz vein, averaging about 6 in. in width, but is lenticular in structure. At a point where the vein intersects a N.W.-S.E. granite dyke, a shaft has been sunk to a depth of 250 ft. The dyke dips steeply to the west, and below the 75 ft. level is to the west of the shaft. Exploration has shown a small lens of ore in the vein lying to the west of the granite dyke. This ore was opened up by a stope from the 75 ft. level to the 50 ft. level, and a few tons of ore was taken from the workings. Exploration at the 125 ft. and 250 ft. levels did not reveal ore of a similar character. The ore is of a peculiar type, being brecciated and containing fragments of greenstone and much calcite with the quartz. The ore minerals are native gold, native bismuth, copper pyrites, iron pyrites, galena, zinc blende, pyrrhotite, and a rare mineral containing lead, bismuth, and sulphur, which was determined at the Department of Mineralogy, Toronto University, to be cosalite.

Charest.—The Charest claim is situated in the south-west of McElroy township. The claim is

on a small stock of massive, coarse-grained, flesh-coloured hornblende and biotite granite. A quartz vein, averaging about 1 in. in width and 300 ft. long, strikes 30° north of west across the granite. Considerable fine gold, pyrite, chalcopyrite, and a grey telluride were noticed in different parts of the vein. Other veins on the property contain molybdenite and specular hematite. Some of the veins contain coarse felspar and are pegmatitic in character, while many of the narrow veins represent the filling of joint cracks. The occurrence of gold in the pegmatitic vein strongly points to the formation of the gold-bearing quartz veins following the pegmatitic veins and representing part of the granite intrusion.

Skead Gold.—Since the spring of 1920 the Skead Gold Mines, Ltd., has had about twenty men under the direction of M. L. Bouzan, prospecting fifty-five mining claims in various parts of Skead township. Encouraging results are being obtained to the west of St. Anthony Lake. Three shafts have been sunk to depths of 50, 14, and 50 ft. on three parallel quartz veins which strike N. 10° E. and dip 60° to 85° easterly. The veins occur in a light grey-coloured andesite rock, which is intruded by an occasional dyke of felspar-porphyry. Some visible gold was found in the central vein near the surface while sinking the shaft. The quartz contains much iron pyrites and, in places, thin seams of molybdenite. Some selected material from the dump at the central vein gave on assay $4·00 in gold per ton. In 1921, a number of narrow veins, quite unlike those just described, were discovered. These veins, which are roughly parallel in an east-west direction, vary from 1 to 12 in. in width, and have been traced 600 ft. or more. They carry iron pyrites, copper pyrites, and specularite, with little or no quartz. From these narrow veins high assays have been obtained, varying from $9·00 to $75·00 in gold per ton. The veins, however, are not closely spaced, eight having been found in a width of 250 ft. at the time of inspection in October, 1921. The andesite and porphyry adjacent to these narrow sulphide seams have been fractured in places over a width of 8 or 10 in., and the cracks have been filled with specularite and sulphides. Additional work may reveal wider veins. A number of pits have been sunk on the veins and a few tons of iron and copper pyrites and specular hematite were obtained, which were shipped to the provincially owned Timiskaming Testing Laboratory at Cobalt for experimental work. It was found that oil flotation would successfully concentrate the copper, after which the gold could be recovered by cyanidation. The higher values appear to come from those specimens which contain considerable pyrite. The company is installing a plant, consisting of boiler, hoist, and four-drill compressor, and intends sinking a shaft and exploring the veins at depth. The company has also done exploration work on several claims east of St. Anthony Lake.

Wisconsin-Skead.—Crossing this property in a N.W.–S.W. direction is a dyke of massive pink biotite granite, porphyritic in places and about 400 ft. in width, with Keewatin greenstone and Timiskamian sediments on the sides. Crossing the granite dyke at right angles are numerous parallel quartz veins which all dip about 40° south. These veins are usually an inch or so in width, although veins Nos. 6 and 11 are approximately 3 and 6 ft. wide respectively, and contain some visible gold and a telluride. No vein was seen extending from the granite into the adjoining wall-rocks. A shaft has been sunk vertically in the granite to a depth of 112 ft. exposing numerous quartz veinlets dipping about 40° south. On the 110 ft. level about 1,000 ft. of lateral work has been done. No. 6 vein occurs along a fault which contains quartz, calcite, pink barite, pyrite, molybdenite, gold, and a telluride. The No 11 vein had not been reached in the cross-cut when the workings were examined in March, 1920. In May, 1921, the shaft was full of water. Much diamond-drilling has also been done. The property has been cleared of the forest; a steam compressor and good buildings have been erected. The company intends obtaining hydro-electric power from the Raven Falls power plant, for further development.

THE RAND REFINERY

In his valedictory address in vacating the presidency of the South African Institution of Engineers, delivered at the meeting held on June 16, R. C. Atkinson gave some particulars of the new gold refinery for the mines on the Rand, in which the chlorine process has been adopted.

To the layman it may appear strange that while South Africa has been the greatest gold producer in the world for many years, the refining of bullion has not been undertaken before now in the country where the metal was produced. The establishment of such a refinery has received consideration from time to time over a number of years. When the Union Government decided in 1919 to establish a branch of the Royal Mint in South Africa, the necessary determining factor was supplied, which finally caused the industry to proceed with the erection of the refinery. In this matter the Transvaal Chamber of Mines represented the industry. R. R. Kahan, of the Perth Mint, West Australia, was asked to undertake the work, in association with a technical committee appointed by the Chamber.

The first step to be taken by the technical committee was, naturally, that of the selection of a suitable site. The requirements as regards the refinery itself and its position in relation to the mines which would be sending their product to be refined having been discussed, various possible sites were visited by the committee, and a unanimous decision was arrived at, the site chosen being that at India Junction, Germiston. The selection of a site required the greatest care; important points, such as easy railway communication by siding, more or less central situation as regards producing mines (the future being considered), easy police protection, etc., as apart from suitable ground for foundations, drainage, etc., had to be fully gone into, and many sites were considered and visited before the final decision was made. As regards the design and general lay-out of the buildings, Mr. Kahan had very definite views on these. The technical committee were entirely guided by him, realizing that his previous experience at Perth and Bombay was a sufficient guarantee that his decisions were based on actual work previously done, and, therefore, a reliable base to go on.

The refining of gold entails a number of processes which are carried out in separate and distinct departments, and as the nature of the work

necessitates that the men employed in each department should remain in their own section and not be allowed ready access to others, the buildings were designed with this end in view, and mess rooms, bathrooms, and conveniences were so placed that the men of any department have access to them without necessarily passing through other departments.

The work of the refinery may briefly be described as follows :—

(a) Receiving the bullion from the mines ;

(b) Melting and sampling the bullion ;

(c) Refining the bullion, that is, removing the silver and base metals contained in the gold ;

(d) Casting the fine gold into ingots as required for export, or for disposal to the mint, and sampling the same ;

(e) Refining the by-products obtained in (c) above, in order to produce fine silver for export, or for disposal to the mint ;

(f) Treatment of residues obtained in the above processes for the recovery of precious metals ;

(g) Assaying at various stages the bullion and residues obtained in the above operations ;

(h) Issuing the fine gold and fine silver bullion, and packing these for export or disposal otherwise.

The buildings were commenced in August, 1920, and consist of :—

(1) The refinery office ;
(2) The assay department ;
(3) The rough gold melting house ;
(4) The gold refining department ;
(5) The silver refining department ;
(6) The chlorine generator house ;
(7) The sweep department ;
(8) The workshops and blower room ; together with stores, coke bins, small boiler house, condensing chamber and chimney stacks, and police guard rooms.

The buildings are surrounded by a boundary-wall enclosing an area of 5½ acres of ground. Four strong rooms are placed in the most convenient positions ; one each in the refinery office, the rough gold melting house, the gold refining department, and in the silver refining department.

The refinery office is a handsome building with Dutch gables and covers an area of 5,907 sq. ft. The various rooms comprise waiting room, manager's and secretaries' offices, record room, stationery store, library, and the public office or receiving hall, where the gold from the mines is received and later packed in the refined state for issue. In one corner of this office a strong room is built, in which the gold is stored as it is received from the mines, pending issue to the various departments to be refined. The whole of the work in this building has been carried out with a view to privacy and safety, as well as general utility and convenience.

The front of the assay department building is in line with the front of the refinery office, similar Dutch gables being a feature of the design, these giving a pleasing appearance to the buildings. The chief feature of the building is the furnace room, which measures 67 ft. by 59 ft., and is 19 ft. high from floor to ceiling. A lantern in the centre of the room, providing light and good ventilation, is 30 ft. by 20 ft., and is 35 ft. high. The muffle and pot furnaces are placed at the northern end of the furnace room, the flues from these passing under the floor to the chimney at the western side. On each side of the furnace room are the rooms for the various processes incidental to this department, which include laboratory, store room, and mess room. Two suites of four rooms for assayers, eight in all, occupy the south end of the building, separated by corridors from the furnace room, the efficient lighting and ventilation of these being a special feature. Hot-water heating has been adopted in these offices. All assays are made in duplicate on different samples by different assayers, using different furnaces, apparatus, etc., and making weighings by different system of weights.

The rough gold melting house and gold and silver refining departments are contained in one large building under one roof, but each department is separated from the other by internal walls. The building is made up of two wings, one at either end, standing parallel to each other and connected up by a central building at right angles to the wings, and centrally placed in relation to them. This has proved the most compact construction for the purposes for which the buildings were required, and obviated the extra walls for entirely separate buildings. The eastern wing, comprising the rough gold melting house, balance room, strong room, offices and mess room, measures 130 ft. by 53 ft. over all. The rough gold melting room contains 32 pot furnaces, the flues of which are taken under the floor to a condensing chamber and main chimney, to be described later, to which the furnaces in other departments are also connected. The centre block of the building, 100 ft. by 53 ft., contains the silver reduction and melting departments, with its office, strong room, mess room, and conveniences. This department contains sixteen pot furnaces, crusher, Chilean mill, and revolving barrels, which are necessary for the production of fine silver from the product of the gold refining branch. The operations in this department cover the extraction of silver from the chloride cakes received from the gold refinery, the result being gold-free silver, which is cast into 1,000 oz. bars for the market.

The gold refining branch, or fine gold melting department, is situated in the west wing, which measures over all 133 ft. by 84 ft. The dimensions of the furnace room are 98 ft. by 80 ft. The remainder of the total space is taken up by the superintendent's office, strong room, and mess room. The melting room is equipped with sixty-four pot furnaces and three tilting furnaces. All of the flues are under the floor, as in the other furnace rooms, and are joined up to the condensing chamber outside the main building and thence to the main chimney. It is in this department that the chlorine gas is passed through the molten gold, and this converts the silver and base metals contained in the gold into chlorides. This is the product which is sent to the silver room for extraction of the pure silver.

The chlorine generator house is placed at the south-east corner of the refinery enclosure, and the roof is supported on columns at regular intervals ; otherwise there are no sides or walls to this building, this being necessary on account of the chlorine gas, a small leakage of which cannot be avoided, and which would otherwise not be able to escape. Here six Edwards oscillating generators for the production of chlorine gas are installed ; these are operated by an electric motor placed overhead in a small concrete house, which spans the roadway between the generator house and the heavy chemical store, the motor being connected through reduction

gearing to a line shaft from which the generators receive their motion, it being possible to unclutch and, therefore, take out of service each generator separately. The raised concrete structure, which contains the driving gear, also serves as a support or stand for the acid tank which contains the acid, and which is directly connected with the generators ; the acid is pumped up to the tank and then allowed to gravitate to the generators as required.

The workshops comprise an engineer's shop of fair size, a small carpenter's shop, and a small smith's shop. In another portion of this building two large Roots blowers and a small air-compressor are installed, together with their motors and electrical apparatus. These are connected and supply air to the furnaces in the several departments. The sweep room contains ball-mills and Chilean mills, as well as lead and cupel furnaces. In this department all sweepings. broken crucibles, and other residues are treated for the recovery of their gold or silver contents. In another portion of the building a portable boiler is installed to supply steam, which is required for the chlorine generators, heating of buildings, etc.

As previously stated, the gases from the refinery furnaces are conducted in flues under the floors and below the ground level outside the building. The flues are arranged so that all gases enter at one point into the condensing chamber. This structure is circular on plan, and is 20 ft. 6 in. internal diameter, and 21 ft. from floor to crown of dome. The dome is struck from two centres ; the radius at haunches is 4 ft. 9 in., and that of the crown 12 ft. A series of steel ropes with specially designed tightening gear is provided at the springing of the dome to take thrusts arising from possible distortion of the brickwork under the high temperatures which will prevail within the chamber when a large number of furnaces are in operation. The chamber is designed to reduce the velocity and temperature of the gases, and will have a system of baffle walls or screens arranged to facilitate the precipitation of dust and volatilized metal which may enter. From time to time all flues, furnaces, and crucibles—in short, all parts coming into contact with the precious metals in the refining processes—will be cleaned out, and, with the sweep, removed to the sweep treatment room for the recovery of the metals contained therein. The refinery chimney is designed to carry off the gases produced by the whole of the 115 furnaces if in operation at the same time. The ruling internal diameter is 4 ft. 6 in., and the height from base to cap is 80 ft. The chimney is lined with firebricks to a height of 30 ft. from the base, the lining being built separately with a cavity between it and the inner face of the shaft. The lower portion has a batter of $\frac{1}{2}$ in. to the foot and the remainder up to the lower part of the ornamental band $\frac{3}{8}$ in. to the foot. The upper portion is vertical. The cavity is closed at the top and ventilated to the external air.

The chimney at the workshops buildings is of similar design, but of smaller dimensions, namely, 4 ft. internal diameter and 66 ft. high. Both these stacks are built with circular-faced and radial-ended stretcher bricks, with alternate rectangular bricks as headers forming flemish bond, in lime mortar, except for the beds and on the inner face, which are in "dagga" to a depth of $4\frac{1}{2}$ in. This was introduced as it was thought that the chlorine which will be passing up the shaft might have injurious action on the lime.

The concrete bases under these chimneys are of such dimensions as to distribute the weight to the extent of less than one ton per square foot.

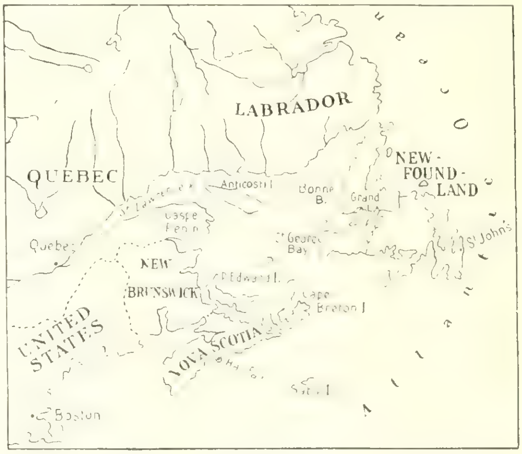
Three large store rooms, 50 ft. by 30 ft., are placed near the south wall, a railway siding being between the stores and the wall. These are fitted for the storage of the various materials, apparatus, and appliances, which are daily required in the process of refining, and each store is placed in the most convenient position as regards its contents, and the building where those stores are used. The railway siding, which is a branch of the mineral line, enters the refinery enclosure through a gateway at the south-west corner, strong iron gates being fitted here to close when the siding is not in use. The coke bins and coal bunkers are also placed alongside the siding to facilitate off-loading railway trucks direct into the bins. Adjacent to the coal bunker and under the same roof, a kitchen and mess room for natives are situated. The switch and transformer house placed near the eastern boundary wall is self-contained, and houses the apparatus for the distribution of electric current to the various motors installed, and lighting the refinery buildings and European quarters. Current is received from the Victoria Falls and Transvaal Power Company at a pressure of 500 volts, and is transformed down to 125 and 220 volts for lighting. A motor-car shelter, sufficient for two cars, together with accommodation for workmen's cycles, is centrally placed, a small kitchen being situated under the same roof for the convenience of the staff. The entrance gate is situated in the centre of the north boundary wall, and suitable guard-rooms are provided on both sides of the gates ; these are furnished for the constant occupation of the police. Outside of the wall and 20 ft. distant an ordinary wire fence is erected all round the refinery wall, the area between the wall and the fence being a prohibited area. To the west of the refinery enclosure, rooms sufficient to house forty natives are situated, and on the same side at some considerable distance a septic tank installation is situated, to which all conveniences in the refinery are suitably connected. On the east of the refinery twenty-two dwelling-houses have so far been erected to house the white employees, and these have been built in a manner which is in keeping with the general scheme of utility combined with pleasing appearance, which is a feature of the entire lay-out.

Coal in Newfoundland.—A paper was read by George Morley before the Mining Society of Nova Scotia in May on coal mining in Newfoundland. This paper is published in the July *Bulletin* of the Canadian Institute of Mining and Metallurgy. Coal is found in two areas in Newfoundland, one on the south side of St. George's Bay, and a small one by Grand Lake and in the valley of the Humber River. Hitherto the only writer on this subject has been the late J. P. Howley, of the Newfoundland Geological Survey. It may be said that the coal deposits are not so extensive or so easily mined as those on Cape Breton Island, so that they have not been attractive as business propositions.

Mr. Morley takes his experience at Coal Brook mine as being fairly representative of the difficulties and ultimate results of coal mining in Newfoundland ; and he adds reports and conclusions

of geologists who have gone over the country in search of economic deposits of coal.

During August and September of 1920 there was a very great stringency in the world's coal market, and Europe was willing to pay almost any price for coal. In August of that year the Newfoundland Government Railway Commission took over the operation of the Newfoundland railways and steamship services from the Reid Newfoundland Company. Their first problem was coal. The Cape Breton companies previously supplying coal to the Newfoundland railways, were naturally disinclined to supply their demands at a lower figure than that paid in the European markets. This led to the consideration by the Commission of the possibilities of working some of the home deposits, which in the days of cheap coal could not be worked profitably. Out of a number of possibilities, the properties of the St. George's Coal Fields Company, at Barachois Brook, St. George's Bay, and the mine of the Reid Newfoundland Company, at South Branch, Cordroy Valley, Grand Lake, were decided upon as being the two most promising areas. Dr. D. B. Dowling, of the Canadian Geological Survey, had previously been asked to visit, examine, and report on the areas at St. George's. Briefly, his report was that "about one and a half million tons of coal could be obtained, with possible developments to a larger amount." The Commissioners visited this property, and they thought favourably of it, and were desirous of developing it; whereupon a survey was run to connect the main railway line with the workings, a distance of 8 miles. This difficulty of securing rail connexions could doubtless have been easily overcome, but the greatest obstacle, and the one which eventually "pigeon-holed" this area, as far as the Railway Commission were concerned, was that they could not arrive at a satisfactory arrangement with the owning company; so the property owned by the Reid Newfoundland Company in the Cordroy Valley was taken up. This property is situated on a small brook, called Coal Brook, which empties into the south branch of the Cordroy River, and it is located in what is known as Reid's Lot 7. The coal seam, with some others, was first discovered in 1897 by the late J. P. Howley. He spent the early part of the summer of that year trenching and sinking trial pits in an effort to prove the seams. Late in August, Mr. Park, a Scottish miner from Londonderry, N.S., was sent with a gang of men to open up some of the seams, with a view to test their permanency underground, and prepare the work for actual mining should the result prove satisfactory. Mr. Park drove a tunnel on the course of the 8 ft. seam, near the base of the bank or just above the level of the brook. He found the coal to be hard and tightly nipped between the walls. It was of excellent quality, being free from pyrites and other impurities. Six feet of coal was removed, 2 ft. being left on the hanging wall to support it. At about 30 ft. in they encountered a roll in the foot-wall, which narrowed their coal down to 4 ft. This roll was very short, being really a projection, and within about 10 ft. from the beginning of the trouble the seam had again increased to 6 ft., but showed signs of deterioration in the shape of earthy and shaley strings with patches of rock. At 60 ft. the coal began to show much more rock, and to thin out. At 90 ft. there was very little coal showing. Mr. Parks spent about a month more in his examination of the measures, and sank a few more trial pits. A close examination of the contact of the coal measures with the older (Silurian) schists at all the places examined left little room for doubt of the existence of a great break, being an up-throw of the older series on the south side. The effect of this was the complete cutting off of the coal measures, which at one time must have occupied an extensive area, and leaving behind a few small segments only of the northern edge of the trough. But one of these appeared to be sufficiently extensive to afford much prospect of being a workable coal seam, at least so far as has been ascertained. It was that which had been uncovered during the greater part of the season. The close proximity of the measures to the line of great disturbance indicated as having, at one period, taken place; and the consequent broken, disturbed, and highly tilted condition of the strata, has undoubtedly much to do with the absence of



Map Showing Position of Newfoundland Coal Deposits.

permanency of the coal seams. By this time the season was well advanced and the work was stopped. Also the Reid's abandoned the idea of constructing a branch railway line to the coal, at least for the time being.

Another attempt to develop the property was made in 1915, under the direction of Hatch and Forbes, geologists of the Natural Resources Department of the Reid Newfoundland Company; and this time with success. At about 2,000 ft. east of Mr. Howley's drift, a tunnel was driven, a few feet above the level of the brook, into a very steep bank, which rose to a height of about 150 ft. The tunnel was driven in through the measures, or roughly at right angles to the strike of the coal. At about 60 ft. in, an 18 ft. seam of coal was encountered, dipping at a very high angle, about 72° from the horizontal, though towards the south it was but slightly inclined. They drove along the seam in both directions. At about 60 ft. the west drift ran out of the coal into the overburden which formed the end of the bank. The east drift was continued for about 300 ft., at which point a pronounced fault was encountered. They drove through this for a distance of about 50 ft. without finding any trace of coal, and finally abandoned the work. They also tunnelled through the measures, in a due northerly direction, but no further coal seams were picked up. Three sets of chutes were con-

structed along the drift, and they then proceeded to extract the overhead coal. This was done by working upwards from the top of the main drift. All the coal was extracted as they advanced, the hanging wall being supported first by leaving in a few feet of coal and timbering heavily from it to the foot-wall, the workmen standing on planks supported by the timber. In this manner over three thousand tons of coal was obtained. This venture was highly profitable. The two heaviest items of expense were the construction of two miles of road, together with some fifteen short-span wooden bridges, and the transport by horse for a total distance of 4 miles. About the only other expense was labour. No mechanical plant was used ; both the coal and water were run out by gravity.

In connexion with this work, a considerable amount of prospecting was carried on. Three diamond-drill holes were put down to a depth of 350 ft. on the line of strike between the tunnel just described and the one driven by Mr. Howley. Every core showed coal, varying in thickness from 4 to 12 ft. Two other holes were put down about a mile east of this, but both caved in before any depth was reached, and this work was abandoned. At about the same time a shaft was sunk midway between the two tunnels to a depth of 95 ft., at which depth the coal began to pinch out. By this time the coal in the tunnel was about worked out, and the season was well advanced ; so all work was stopped, and the different workings closed up.

From the results of this exploration it was thought that the seam ran continuously from the fault in the east side of the 1917 working, through the shaft, and on to the tunnel driven by Mr. Howley, a distance of 2,500 ft. They knew they had a depth of at least 100 ft., as the shaft proved this. The width of the coal in this 100 ft. of depth was found to be from 20 ft. near the surface down to 5 ft. at the bottom, where it began to pinch out. From this block it was estimated that 60,000 tons could be obtained, or about four years' supply for the western division of the railway.

Mr. Morley then gives the results of the work of the Government Railway Commission. In August, 1920, the Commissioners visited the old workings of the Reid Newfoundland Co., at Coal Brook mine, being accompanied by Mr. Hatch and Mr. Forbes of the Natural Resources Department of the Reid Newfoundland Co. It was found expedient, both for present needs and with a view to develop a cheap supply of railway coal for the future, that the existing shaft be sunk deeper and equipped with the necessary hoisting gear, boilers, engines and houses for the staff and workmen, and that the mine be developed from these beginnings. The question of haulage of the coal from the mine to the railway presented a difficulty in view of the limited amount of coal which Mr. Hatch and Mr. Forbes were able to give assurance of being obtainable. It was found that it would not pay to spend more than $2·00 per ton on the development of this coal body, or, say, $120,000 in all, so that a railway was out of the question, the distance being over 3 miles. A public road existed for 2 miles, and by improving it and extending it to the mine the problem of transport was solved. Four 5 ton trucks were purchased, and put in use for transporting the coal from the mine to the railway. A loading platform was also constructed. This was done by deepening and widening a valley, the sides of which were quite steep. The highland to the east, being flat, permitted the trucks to run in to the platform on the level. The railway cars were lowered down the valley close to the edge of the platform, from which a chute of width equal to the length of the cars, was built to the cars. Thus the coal was dumped out of the motor-trucks on to the chute and slid down into the cars. It was not necessary to use a shovel during the whole operation, excepting for the final trimming of the cars before they were moved off.

The situation at the mine was almost identical. The coal was hoisted in a 1 ton skip, which dumped automatically into a bin on the head-frame. From this the coal was drawn off and run out to the storage and loading bins. The motor trucks were backed in under these latter, the chute gates lifted, and their load drawn off. For this whole operation one man only was employed, and it was accomplished usually in about five minutes. Underground an attempt was made to deepen the shaft, but the coal pinched out very rapidly. Also, water became very troublesome, so it was decided to sink no further, but later to sink a winze from the level, drive back to the shaft, and rise, it being assumed that the pinch was local. From the shaft, at a depth of 90 ft., levels were driven east and west. On the west side there was the same trouble as Mr. Howley had ; in his hillside tunnel there was good coal for the first 80 ft., but from that to the end of the level, about 180 ft., the coal was so mixed with clay and shale that there was no choice but to waste it. On the east side a distance of 200 ft. was driven, and at that point a fault was encountered. A tunnel, 160 ft. long, was driven through this, and where the seam was again picked up it measured 5 ft. thick at the bottom of the level and 6 ft. at the top, a gain of one foot in seven. The proposed winze was not put down, as it was known that the pinch encountered in the shaft was not local, but that the seam was faulted at that depth. Five rooms were driven upon the east side, and one on the west. The coal varied in thickness from 10 ft. to 30 ft. or so. Twenty-foot pillars were left between rooms, which averaged about 14 ft. in width. The depths varied from 20 ft. in some to 10 ft. in the shallow ones. The height depended on the nature and thickness of the cover, the highest being 70 ft., while two were only 35 ft.

As already explained, the seam was almost vertical, so room driving was all overhead work. Sufficient coal was left in the rooms for the workmen to stand upon. To mine the coal it was only necessary to bore, shoot, clean down any hanging or dangerous coal, and timber the hanging wall, which was exceedingly friable. Manways were timbered off at one side of the room. At every 30 ft. in height cross-cuts were driven between rooms, and in every second pillar a 3 by 3 ft. emergency manway was driven. At the bottom of each room a pair of chutes were built, and through these the coal was drawn off into the car on the level. The skip dropped down below the rail of the level, thus permitting the coal to be dumped directly out of the car into the skip.

This mine was not a success from a financial point of view, but from other aspects it was by no means a failure. Firstly, it provided employment during a particularly hard year ; secondly, it justified its existence in that it supplied coal to the railway at a time when its stock was almost

exhausted; and thirdly, money spent in proving mineral areas is not lost or wasted. The coal itself is in appearance anthracitic, being glossy and black; it burns with a short luminous flame, giving off no soot, and practically no smoke. It does not coke or clinker, and leaves a whitish or grey ash. It is very soft, and with much handling or weathering breaks down to a slack.

The story of Coal Brook mine may be taken as typical of the different attempts that have been made in Newfoundland up to the present to mine this all-important commodity. Mines open up, operate for a period with varying degrees of success, and close down again. In one respect, at least, Newfoundland is not unlike Cape Breton; almost anywhere between Port aux Basques and Grand Lake an enthusiastic owner can be found who is very willing to put a financier on the way to making a million, and to borrow a quarter.

Mining Methods. — In *Mining and Metallurgy* for July, C. F. Jackson gives particulars of the doings of the American Institute's Mining Methods Committee. The object is to prepare an elaborate record of mining methods according to the following suggested plan: (1) To present a general classification of mining methods, showing their inter-relationship, and at the same time provide a common language for the discussion of mining methods and a nomenclature that will have the same meaning wherever used. (2) To show the relationship between the physical characteristics of the deposit, the economic considerations, and the mining method. It is not proposed to treat this subject as a mere academic problem, but to secure reports from every mining company of importance in America, which will show what methods or modifications and combinations of methods have actually been applied and the physical conditions and economic considerations which have led to the adoption of these methods in each case. (3) From the reports submitted, which are to include detailed unit production data (not costs), it is hoped to present on a comparable basis as between methods, the economic results obtained by different methods applied to mineral deposits of similar physical character as regards size, dip, grade, and distribution of values, strength of ore-body, enclosing rocks, etc. The comparison will be on both the basis of unit production and percentage extraction of ore and valuable mineral. The reports should also show the evolution of the finally adopted methods from the methods first tried in each case, and the comparative results obtained by initial and finally adopted methods.

As a guide to the classification of methods employed in the United States, the Institute has issued the chart accompanying this article. We would suggest that engineers in other countries should send information as to their experience. The collaboration of other institutions connected with mining would be helpful. For instance methods of mining Spanish pyrites might be included.

AMERICAN INSTITUTE'S CHART OF MINING METHODS

OPEN CUT, WITH OR WITHOUT STRIPPING	Benches		
	Glory Holes and Milling		
	Placer Mining	Hand Sluicing	
		Dredging	
		Hydraulicking	
UNDERGROUND METHODS	*Breast Stoping* (Tabular, flat-dipping deposits or beds)	Continuous Horizon	
		Casual Pillars	
		Room-and-Pillar	
	Underhand Stoping (Veins and large masses)	Glory Hole and Milling	
		Open Stope	With Pillars
			With Stulls
			With Square-set Timbering
	Overhand Stoping (Steep-dipping veins or masses)	Open Stope	With Pillars
			With Stulls
			With Square-set Timbering
		Filled Stope	Horizontal Cut and Fill (Flat-back)
			Inclined Cut and Fill (Rill)
			Square-set Timbering
			Resuing or Stripping
		Shrinkage Stope	
		Sublevel Stopes	
	Top Slicing (Wide veins or masses)	Continuous Horizon	
		Panel Slicing	
		Block Slicing	
		Inclined Slicing	
	Caving (Large masses)	Sublevel Caving	
		Block Caving	Undercut from Main Level
			Undercut from Sublevels
			Back Caving into Chutes
			With Branch Raises
	Combined Methods (Large masses)	Alternate Shrinkage Stope and Pillar. Pillars Mined by: Top Slicing, Sublevel Caving, or Block Caving	
		Square-set Timbering: Pillars Mined by Slicing	

Potash Deposits in South Africa.—In May and December, 1919, we gave some information relating to the deposits of potassium nitrate in the Prieska and Hay districts of the Cape Province, on the latter occasion quoting from the report of A. L. Hall, of the Geological Survey. These deposits are visible in the sheltered ledges of the rocks in these districts. The salts are found in the ground water and in " pans " or stagnant lakes, together with other salts. Since then detailed examinations have been made, particularly of the Matzap " salt pan." An article describing the work, written by H. O'K. Webber, until recently a prominent member of the Rand Mines group, appears in the *South African Journal of Industries* for June. Mr. Webber quotes Mr. Hall, who, in his report, dealt with the origin of the nitrogen, and put forward the suggestion that the potassium, probably an original constituent of the Lower Griquatown Series, passed through the carbonate into the nitrate combination in the presence of nitric acid.

All attempts made so far to collect the nitrates from these ledges and market them on a commercial scale have failed. However, the presence of these deposits, saved in crevices from destruction or removal, suggests that there existed for a vast number of years conditions most favourable to the manufacture of nitric acid by bacteriological action upon vegetable and even animal matter, and least favourable to denitrification. That is to say, conditions favourable to nitrification must for ages have preponderated over those favourable to denitrification. This long-continued preponderance of the formation of nitrates over their destruction, and the fact that they are still preserved in protected spots, warrants the supposition that a great quantity must have been dissolved and carried by the solvent water deeper into the ground. Consequently, thanks to the porosity of the soil, and to conditions which retard the activity of denitrifying organisms, a large balance of dissolved nitrates must have found its way to a depth below which percolation was no longer possible. During this process of gradual but perpetual percolation and loss of water to the air in the soil, concentration would take place, until the water which originally carried a minute quantity of salts is held up in the form of strong nitrate-bearing brine. It is known that the superficial rocks of the district are fairly porous, and they might hold a large volume of this brine per square mile of area, where it may be correct to say it lies beyond conditions favourable to the action of denitrifying organisms. It is only by exploring underground that evidence of such accumulations can be obtained, and in this connexion Mr. Webber has taken pains to ascertain whether there is in the district evidence of the presence of nitrates in any underground water at present tapped in sunk wells. Various Dutch farmers owning land, both north and south of the Matzap salt pan, claim that the water in their wells contains an appreciable quantity of potassium nitrate. This information has been checked by the writer in the case of wells sunk about two miles away from Matzap on the adjoining farm. There it is proved to be correct.

The bore-holes lately put down within the area of and near the Matzap pan demonstrate what has happened to some of the nitrates originally formed in the surface soil during perhaps thousands of years. These boring operations disclose the existence of underground brine-carrying beds, which appear to be extensive. The country is flat in the neighbourhood of Matzap, the fall from the north-east towards the pan being very slight.

The pan was first officially noticed in 1905 by Dr. A. W. Rogers, of the Geological Survey, as recorded in the Tenth Annual Report of the Survey (1906). Dr. Rogers describes attempts made, by the then owner of the farm, to evaporate brine drawn from the pan in a rough open tank. He says that some salts had been thrown out of the mother liquor on to the ground, where they had dried in the sun. These mixed salts consisted of NaCl (common salt), $MgSO_4$ (epsom salts), and KNO_3 (saltpetre), with a little gypsum, while the mother liquor which was thrown away consisted mostly of $MgCl_2$ (magnesium chloride), and probably some nitrates still not crystallized.

The writer has been informed by the son of the Dutch farmer who then owned the pan, that this production of salt was not long continued. He states that although endeavour was actually made to throw out from the mother liquor the NaCl (common salt) at an early stage of precipitation, yet the salt sold soon earned a bad reputation for making livestock thin. This may or may not have been deserved. At any rate, the presence of $MgSO_4$ and KNO_3 (epsom salts and saltpetre), and probably some $NaNO_3$ (sodium nitrate), evidently constituted what the farmers, unlearned in chemistry, considered the undesirable feature in the cattle salt.

The brine was drawn by bucket from a shallow sump in the pan, and no attempt was made by the late owner, or by anyone else, to ascertain its occurrence at depth. The late owner then died, leaving a widow with a family of children, in addition to many children by a former marriage, and alienation of the property was rendered impossible, by the testament of the deceased father, until the mother's death. In 1918, however, the mother died, and in 1919 the farm was sold, and the new owners proceeded to ascertain the value of the contents of brine, not only near the surface, but at depth.

For about eight months in the year the pan, which is kidney-shaped and has a circumference of about $3\frac{1}{3}$ miles, is dry on the surface, the water level varying then from about 1 to 2 ft. down. For about three months it is covered with water, the usual surface depth of which is, then, at most about 2 ft. The greatest depth of this surface water in the last twenty-five years has not exceeded 4 ft. 6 in. This depth was during the unprecedented flood of 1920, and even then no animal would drink the water. There is no visible overflow. When a sump is sunk the brine comes in freely from below, so freely, indeed, that at a depth of from 6 to 16 ft. from the surface pumping has to be resorted to in order to keep it down. The average analysis of this brine in a test-hole down to 16 ft. is as follows, given in round figures, per weight of brine: NaCl, 10%; $MgSO_4$, 2%; $MgCl_2$, 2%; nitrates, $1\frac{3}{4}$%. The specific gravity of the brine in the western half is greater than it is in the eastern half of the pan. If, when the surface is covered with water, the sump is protected from inflow of any surface water, it is found that the specific gravity of the brine which comes into the sump is not lower than it is when the surface is dry. This refers also to the period following the flood of 1920, when the brine was tested as soon as the level of the surface water had fallen to 2 ft. in depth.

In 1921 systematic boring with a 3 in. drill and casing was undertaken. Five holes were put down in the pan, so as to embrace roughly the whole area. Below 16 ft. the core showed the presence of a bed of dry soft shaley clay, of a thickness varying between 10 and 32 ft., below which a strong brine was again encountered. Whenever this fact was fully established boring was discontinued. The following analyses of the brine drawn from the bottom of these holes were made by Mr. McArthur Johnston.

SALT CONSTITUENTS OF BRINE IN FIVE BORE-HOLES, RECKONED IN GRAMMES PER 100 CC.

	No. 1	No. 2	No. 3	No. 4	No. 5
Sodium chloride . . .	9·70	8·17	8·65	8·49	9·31
Magnesium sulphate . .	2·91	3·69	2·69	2·84	3·08
Magnesium chloride . .	4·47	5·11	4·84	4·67	4·79
Alkaline nitrates calculated to potassium nitrate	5·77	5·25	5·50	4·29	4·09
	22·85	22·22	21·68	20·29	21·27

In considering the Matzap pan, the points of interest are the following :—

The upper bed of sandy clay, approximately 16 ft. thick, is saturated with nitrate-bearing brine, containing an aggregate heavy tonnage of valuable salts, and also the specific gravity of this brine does not appear to vary in consequence of the surface of the pan being flooded, provided the surface water is excluded from the sump.

The water of a small perennial spring, which trickles into the pan on the north-east side, contains a small quantity of nitrates.

The analyses of the soil near the surface of the pan, taken as dry as possible, shows the presence of from 1 to 2% of nitrates.

One would assume that under the fierce rays of the sun and drying winds for eight rainless months every year, when the surface of the pan has become dry, the specific gravity of the upper brine would be greater than that of the lower brine. On the contrary, the brine found at depth over the whole area of the pan, below the layer of dry shaley clay, is much more highly concentrated, and from the tests recorded above contains between 4 and 5¾ tons of nitrates calculated to KNO_3 per 20,000 gallons of brine, lying where no external influence inducing concentration can be brought to bear on it. This would indicate that this underground brine represents a store of uncertain extent and of uncertain age. It also points to the probability of a slow underground flow of brine towards the pan. This may be a movement of accumulations, and they in turn may be replenished by slow percolation and diffusion. Moreover, the writer has no reason to doubt the statements made to him to the effect that the water found in wells, especially on the watershed, which is flat but very large, is found to be nitrate-bearing at varying depth.

In considering the quantity of brine that could be pumped daily, one can only point to the large quantity of brine which is pumped daily from below the dry salt pans of the western parts of the Union. No solution is offered to the problem of the source of these underground supplies of brine, which seem to have means of replenishment. Those who have put up pumping plants on salt pans for raising the brine from bore-holes, and also expensive evaporating plants, appear to have no qualms about the permanency of the supplies. For instance, at the Britten saltpan in the western Transvaal only a fraction of the pan is so far worked. In spite of this, about 250,000 gallons of brine is pumped daily from about twenty bore-holes, mostly about 70 ft. deep, a few being 200 ft. deep, without cessation or signs of diminution.

Extraction of Nitrate of Soda.—British Patents Nos. 7,533 and 23,759 of 1921 (182,859) describe the process for extracting nitrate of soda from caliche, invented by Walter Broadbridge, Edwin Edser, and W. G. Sellers, and controlled by Minerals Separation, Ltd. Reference was made to this process in the report of the Minerals Separation for 1921, as recorded in our last issue. We quote from the specification herewith.

In the existing process the caliche is crushed and the water-soluble constituents are dissolved out by hot water ; the solution is concentrated, decanted from the undissolved matter, and allowed to cool, whereupon the crude sodium nitrate crystallizes out. The percentage of recovery is very poor, one reason being that if the caliche be crushed only into large lumps (one or two inches in diameter), as is customary, the extraction (dissolving of sodium nitrate) is only partial, while if the crushing is carried much further, slimes are produced which will not readily settle and cannot be economically removed by filtration. The inventors propose to employ a process in which the caliche is crushed to such a degree as to ensure effective extraction of the sodium nitrate by the solvent liquor, and in which special steps are taken to prevent the slimes from remaining in suspension in the solvent liquor. The inventors have discovered that where any strong solution of sodium nitrate containing slimes in suspension is agitated (preferably with aeration) the slimes tend to become flocculated, and in this condition they are deposited readily on a filter bed ; for example, they are deposited readily on the undissolved residues of caliche as the solution percolates through a bed of caliche.

The invention comprises a method for the extraction of sodium nitrate from caliche in which the heated solvent liquor is circulated through the body of crushed caliche and through a vessel containing an impeller, whereby the liquor is subjected to agitation, preferably with aeration, to flocculate the slimes or finely divided material suspended therein, so that they may settle on a filter bed ; for example, so that they settle on the undissolved residues of the caliche while simultaneously the nitrates and other soluble salts are dissolving in the solvent liquor. The circulation of the solvent liquor through the bed of caliche accelerates the solution of the nitrates and other soluble salts, and it is important that the liquor should become clear by the time the saturation point is reached. It is therefore important to obtain control of the rate of flocculation of the slimes. The inventors have discovered that flocculation of the slimes can be effected or assisted by adding small quantities of certain substances (flocculating agents) to the circulating solvent liquor and that the flocculated slimes adhere to or accumulate upon the undissolved residues of the caliche as the liquor passes through the bed of caliche.

SHORT NOTICES

Loading Machines.—*Engineering* for August 18 describes portable loading machines of the continuous bucket-line type made by the Jeffrey Manufacturing Co., Columbus, Ohio.

Pumps.—The *Engineer* for August 11 describes and illustrates a small silent plunger pump made by the Pulsometer Engineering Company.

Diamond-drilling for Oil.—In the *Engineering and Mining Journal-Press* for July 22, E. R. Lilley gives information relating to recent application of the diamond-drill to exploring for oil and sinking oil-wells.

Cementation Process. — The *Colliery Guardian* for August 18 contains a paper on repairing a leaky shaft tubbing by the cementation process, translated from an article by H. Morsbach in *Gluckauf*.

History of Mechanical Roasting. — *Mining and Metallurgy* for August contains a paper by L. S. Austin on the evolution of mechanical roasting in silver-lead smelting.

Zinc Metallurgy.—In the *Engineering and Mining Journal-Press* for August 5, J. F. Cullen and T. E. Harper discuss details of practice in the ammonia leaching of zinc ores.

Zinc Dust. — The *Chemical Trade Journal* for August 18 contains a paper on zinc dust and its uses, translated from an article by A. Billaz in *L'Industrie Chimique*.

Chemical Lead.—In *Chemical and Metallurgical Engineering* for August 2, Thomas French writes on chemical lead and the causes of its failure, discussing the effect of various impurities on its physical properties and technical value.

Nickel Analyses.—The *Journal* of the Society of Chemical Industry for August 15 contains a paper by F. E. Lathe on the analytical problems encountered in the metallurgy of nickel.

Geology of British Columbia. — A paper is being presented by P. D. Wilson at the San Francisco meeting of the American Institute of Mining and Metallurgical Engineers on the geology and mineral deposits of the coastal region of British Columbia and Southern Alaska.

Dolly Varden Mine. — The August *Bulletin* of the Canadian Institute of Mining and Metallurgy contains a paper by G. Hanson on the Dolly Varden silver mine, Alice Arm, Northern British Columbia.

Canadian Iron Ores.—*The Canadian Mining Journal* for July 14 and 28 contains an account of a conference between the Ontario Minister of Mines and the owners of iron ore deposits, metallurgists, and geologists, with a view to studying the possible development of iron ore in Ontario. The account includes a statement on the subject by G. C. MacKenzie, secretary of the Canadian Institute of Mining and Metallurgy.

Sierra Leone.—The *Geographical Journal* for July contains a paper by Frank Dixey on the physiography of Sierra Leone, West Africa.

Uranium and Radium in Utah. — In the *Engineering and Mining Journal-Press* for August 12, F. L. Hess describes uranium-bearing asphaltite sediments in Utah, which are being worked for radium.

Geology of Patricia.—In the *Journal of Geology* for August, E. M. Burwash describes the pre-Cambrian rocks of Western Patricia, Canada.

Petroleum in Borneo. — In *Economic Geology* for August, A. H. Redfield writes on the petroleum occurrences in Borneo.

American Potash.—In *Chemical and Metallurgical Engineering* for July 26, W. H. Ross and W. Hazen describe the method of removing borates from potash produced at the Searles Lake and other deposits in California and Nevada.

Malayan Railways.—The *Engineer* for August 4 contains an illustrated article on the present railway service in the Malay peninsula with notes of intended additional lines.

Hydro-Electric Power for Scotland.—*Engineering* for August 11 gives particulars of the scheme for erecting hydro-electric power plant in the Grampian Mountains, north Perthshire, and east Inverness.

Lonely Reef. — The *Engineer* for August 25 contains an illustrated description of the gas engines and gas plant using wood fuel employed at the Lonely Reef gold mine, Rhodesia, for producing electric power. The plant was supplied by Crossley Brothers, Ltd., and the Premier Gas Engine Co., Ltd.

Peat Excavation.—The *Canadian Mining Journal* for August 4 contains an article describing the work of the Anrep-Moore peat excavation plant and the preparation of peat fuel.

Wright's Rope Works. — The *Iron and Coal Trades' Review* or August 18 gives an illustrated description of the Universe Rope Works, Birmingham, of John and Edwin Wright, Ltd.

Hadfields' Steel Works.—The *Iron and Coal Trades Review* for August 11 gives an illustrated description of Hadfields' Hecla and East Hecla steel works, Sheffield. An article on the new rolling-mill shop at East Hecla works appears in the *Engineer* for August 11.

RECENT PATENTS PUBLISHED

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.*

2,449 of 1921 (183.159). J. P. Roe and Ropeways, Ltd., London. Improved grips for attaching carriers to the hauling ropes in aerial ropeways.

4,869 of 1921 (182,846). Hinselmann & Co., and K. T. Jasper, Essen-Ruhr. Improvements in coal picks driven by compressed air.

5,967 of 1921 (183,504). F. B. Jones and Minerals Separation, Ltd., London. Method of separating coal from shale by flotation, particularly referring to sizes between one-tenth and one-half inch in diameter.

6,299 of 1921 (183,507). American Smelting and Refining Co., New York. In electrolytically refining tin, using a comparatively low percentage of tin in the electrolyte, say, 6% or less, by adding cresylic acid or other of the phenol series so as to decrease the amount of hydrofluosilicic acid necessary.

6,929 of 1921 (182,511). E. Morgan, Derby. Improvements in telescopic pit props.

7,119 of 1921 (182,851). George Cradock & Co., Ltd., and W. J. Adan, Wakefield. Improved carriage for aerial ropeways, and improved method of hauling it.

7,597 of 1921 (161,165). V. M. Goldschmidt, Christiania. Method of making anhydrous magnesium chloride.

7,572 of 1921 (182,860). S. Bruno and O. Natalini, Genoa. A rock-tunneling machine in which a large rotating cutter is used, of a diameter equal to the tunnel to be cut.

8,530 of 1921 (160,427). A. Pacz, Cleveland, Ohio. In the alumino-thermic process, for the purpose of obtaining a still higher temperature, the use of alloys of aluminium and rare metals such as cerium and lanthanum, and a method of making such alloys.

9,114 of 1921 (182,526). A. Arutunoff, Berlin. System and apparatus for raising petroleum and other liquids from bore-holes and wells.

9,495 of 1921 (161,138). R. S. Ransom, Hazelton, Pennsylvania. Improvements in hydraulic jig-separators.

9,618 of 1921 (182,539). L. B. Woodworth and S. T. Tregaskis, Johannesburg. Improved construction of magnetic separators of the travelling belt type.

10,830 of 1921 (169,950). W. E. Trent, Washington. A combination process in which iron ore is reduced to metal and the coal used is distilled for the production of oil and other by-products.

11,047 of 1921 (183,216). T. G. Nyborg and M. F. Higgins, Sheffield. Method of holding tools in hammer drills.

11,093 of 1921 (183,535). T. Rigby, London. Improved method of dewatering china-clay.

11,596 of 1921 (183,260). H. Otto, London. Method of charging aerial ropeway buckets while they are in motion.

12,129 of 1921 (182,609). L. Burgess, New York. Method of producing aluminium by mixing aluminium oxide or crude bauxite with carbon and agglomerating the mass with pitch and treating the mixture in an electric furnace.

12,810 of 1921 (182,623). M. A. Jullien, Paris. Improved method of producing copper and other tubes by electrolytic deposition.

15,814 of 1921 (183,323). D. Tyrer, Stockton-on-Tees. Method of producing red oxide of iron pigment from ferrous chloride waste in galvanizing.

18,840 of 1921 (182,689). E. E. James, San Francisco. Apparatus for use in the production of steam by the action of molten slag.

18,949 of 1921 (182,693). H. Hetherington and W. A. Allsebrook, Matlock. Method of making lead chromate pigments.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

Iron Ore Resources of South Australia. By R. Lockhart Jack. Published by the Government of South Australia.

Iron Ore: Foreign Asia. Part 8 of the series of reports on the iron-ore resources of the world, published by the Imperial Mineral Resources Bureau. Price 2s. 6d. net.

Mining Laws of South Africa. Part I, General Principles Applicable to South Africa: The Transvaal. By Gilbert Stone. Vol. 3 of the handbooks of the mining laws of the British Empire and foreign countries, published by the Imperial Mineral Resources Bureau. Price 30s. net.

Syllabus of Classes at the Sir John Cass Technical Institute for the Session commencing September 25, 1922. The courses of instruction at the Institute meet the requirements of those engaged in chemical, metallurgical, electrical, petroleum, and the fermentation industries. Full facilities are provided in the well-equipped laboratories of the Institute for special investigations and research. The instruction in experimental science also provides systematic courses for the examinations of London University and of the Institutes of Physics and Chemistry. Special courses of higher technological instruction form a distinctive feature of the work of the Institute, and for the forthcoming session these include brewing, malting, microbiology, petroleum technology, colloids, alternating currents and electrical oscillations, mathematical statistics, metallography and pyrometry, heat treatment amd mechanical testing of metals and alloys, and foundry practice.

Electrical Handling of Materials; Vol. III, Electric Cranes. By H. H. Broughton. Cloth, quarto, 340 pages, illustrated. Price 50s. net. London: Benn Bros., Ltd.

Essentials for the Microscopical Determination of Rock-Forming Minerals and Rocks. By Albert Johannsen. Cloth, quarto, 60 pages. Chicago: The University Press.

Income Tax Guide. By Herbert W. Palmer Pamphlet, 40 pages. Price 1s. net. London: *The Financial Times*. In these days of high taxes and reduced incomes, most people will do well to consult this guide so as to ascertain all possible legal ways of securing relief.

An Introduction to Sedimentary Petrography: with special reference to loose detrital deposits and their correlation by petrographic methods. By Henry B. Milner. Cloth, small octavo, 125 pages, illustrated. Price 8s. 6d. net. London: Thomas Murby & Co.

Graphical and Tabular Methods in Crystallography. By T. V. Barker. Cloth, octavo, 150 pages, illustrated. Price 14s. net. London: Thomas Murby & Co.

COMPANY REPORTS

Rayfield (Nigeria) Tin Fields.—This company was formed by Oliver Wethered in 1912 to acquire alluvial tin properties in Northern Nigeria, and further properties were acquired in 1919. The chief properties now worked are the Top, Shen, and Delimi areas. The company also holds interests in the Keffi Consolidated and in several Cornish companies. The report for 1921 shows that 420 tons of tin concentrate was produced, as compared with 462 tons during the previous year, and that the financial result is a loss of £6,000. Like most Nigerian companies, this company has been hit by the drop in the price of tin, and the expenses and scale of operations have been cut as far as possible, while the large reserves of ground are being conserved for better times. The capital of the company is to be reduced, on terms recounted under " Review of Mining ".

Waihi Grand Junction Gold.—This company was formed in 1897 to work gold deposits in the Upper Thames district, New Zealand, contiguous to those of the Waihi company. As already mentioned in the Magazine, mining and milling were suspended in February of this year and the labour concentrated on development, on the advice of the company's new consulting engineer, H. Stansfield, formerly of the Talisman. The report now issued covers the year 1921. During this time 73,880 tons of ore was raised and sent to the mill, and the gold and silver extracted realized £117,894. Other items of revenue brought the total receipts to £125,625, and the total debits were £143,387, showing a loss of £17,761. There was also a loss of £3,554 on the realization of investments. As compared with the previous year the amount of ore treated was 16,430 tons less, and the revenue per ton was 28s. 11d. in 1921 as against 33s. 8d. Developments during the year yielded indifferent results, and the ore milled became of lower grade. Owing to the inability of the mine to make a profit, Mr. Stansfield recommended the suspension of milling, as already recorded.

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CONTENTS

EDITORIAL

WE have pleasure in announcing that the Prince of Wales has accepted an invitation to be present at the dinner of the Institution of Mining Engineers and the Institution of Mining and Metallurgy to be held at the Guildhall on Thursday, November 16. The Prince, as Duke of Cornwall, is keenly interested in mining, and his presence at a function of the societies representing the mining profession will be gratefully recognized as further evidence of that interest. The dinner forms part of the programme of the annual meeting of the Institution of Mining Engineers on November 16 and 17.

THE papers issued by the Department of Scientific and Industrial Research, like most Government publications, are not adequately advertised; they are not attractively printed, and they are bound in flimsy paper covers. The volumes on colloid chemistry are for this reason known only to a select few, so we take this opportunity of drawing attention to Vol. IV, which is mentioned on page 254 of this issue, and which will be reviewed later.

IN a letter to *Nature*, a correspondent mentions the surprising fact that lead compounds act as a tonic to certain members of the animal kingdom. He instances experiments on caterpillars fed on vegetation that had been treated with lead nitrate, and shows that these eat more rapidly and grow faster than with normal food. He also mentions that in Weardale the farmers choose pastures near the lead smelters when fattening sheep for market. It must be confessed that these statements are reminiscent of skilled evidence in the courts in damage-by-fume cases, and some corroborative evidence is desirable. Perhaps some friend who knows Weardale will be able to say if the statement as to sheep has any basis of fact.

LAST May, Mr. W. E. Simpson wrote an article in the MAGAZINE announcing the use of diethyl telluride for ensuring smooth running in petrol motors. Since then the chemists of the United States Bureau of Mines have been investigating this invention. They report the use of 0·2% of this compound in petrol as an anti-knock compound. Its action is to eliminate carbon deposits and to increase the efficiency of motors employing very high compression. Its use would involve a special design of engine, so that it is not applicable for general use in all motors. The poisonous nature and unpleasant smell of the gas are unfavourable features. The invention, however, appears to be a notable one, and experiments are being continued.

PETROLEUM technology occupies a prominent place in the syllabus of studies at the Sir John Cass Technical Institute, Jewry Street, Aldgate. The course occupies two years, and the lectures are on oil-well technology, the chemistry of petroleum, refinery technology, the geology of petroleum, surveying, mechanical drawing, and the materials of construction and design. For those not versed in elementary science, there is a preliminary course on chemistry, physics, and mathematics. The Institute has been able to secure the services of competent lecturers, and the presence of leading men in the oil world on the consultative committee has been very helpful in many ways.

STUDENTS at the Imperial College of Science and Technology who have matriculated at the University of London may proceed to the degrees of the University as internal students. This regulation makes it possible for School of Mines men to take the London degree of B.Sc. with honours in mining and metallurgy. The degree position continues, however, to be anomalous, for though the Imperial College is a recognized school of the University and the responsible staff are recognized teachers, the College is not an integral part of the University. As we have many times written, the Imperial College should either be given university rank independently, or it should become part of the University of London. Agitation continues in various quarters in favour of these alternative choices respectively, the first being favoured by those interested aggressively and particularly in the Imperial College, and the second by the champions of London University and by those supporters of the Imperial College

who believe in the theory of the line of least resistance. We have already expressed ourselves as "least-resistancers," but we shall be far from annoyed if the out-and-out backers of the College eventually gain the day.

Funds for Dolcoath

It was announced by the directors of Dolcoath toward the end of last month that the Advisory Committee appointed under the Trades Facilities Act had agreed to recommend the granting of a Government guarantee to the extent of £50,000 for the purpose of assisting exploration and development at certain sections of this company's property. It is important to realize that this scheme to be partially backed by the Government is not in any way a "reopening of Dolcoath," as many people have imagined, but the inauguration of exploratory work on lodes three-quarters of a mile to the north of the old workings. In order to grasp the situation it is necessary to recapitulate recent history. Three years ago it was realized that the main lode at Dolcoath was exhausted in depth, and that further sinking below the 550 fathom level was therefore inadvisable. It was then decided that trials should be made at depth of the ground to the north, in the North and South Roskears, and a proposal was made to drive a long cross-cut in this direction on the 338 fm. level from the Williams shaft, in order to intersect the lodes in question. The reason for proposing this cross-cut was that thereby the Williams shaft, a vertical shaft sunk at great expense, but hitherto of little value to the company owing to the exhaustion of the Dolcoath main lode, would be utilized and the money spent on its construction would therefore be not entirely wasted. Subsequently it was recognized that this scheme would be more expensive than sinking a new shaft at the Roskears, and moreover there would be difficulties in coping with water in the cross-cut. All cause for argument as to the relative advantages of the two schemes was finally removed, however, by the water rising in the main workings and the impossibility of facing the big expense that would be involved in unwatering them. Thus there is now unanimity as to the plan for sinking a new shaft at the Roskears. It is not necessary here to go into details with regard to the prospects at the Roskears, for a full account was given, with plan and section, in the MAGAZINE for January, 1921, when reports by Mr. R. Arthur Thomas and Messrs. Bewick, Moreing & Co. were published in full. Suffice it to say that in days gone by the two Roskears were important producers of copper ores, and that in the bottom of the old workings at 300 fm. tin was beginning to make its appearance when operations were stopped. The workings had not at the time reached any granite, though the country rock showed signs of its near approach. At South Roskear there were two shafts 2,000 ft. apart, and at North Roskear there were five. In 1871 the late Captain Josiah Thomas was keen on sinking into the granite, but the prices of copper and tin declined, and the amount of capital available was inadequate for the purpose of comprehensive development at depth. The present scheme for the reopening of these properties comprises the sinking of an entirely new modern shaft, for, as Mr. Moreing said at a meeting of workers recently, Cornishmen must rid themselves of the old ideas that old shafts can be utilized. Another point in connexion with the Government guarantee for this scheme is that the shareholders and others interested are expected to provide an additional £70,000, so that the total available funds will be £120,000. Although it may be necessary to wait till the 17th inst.—for which date the meeting is called—for details, we understand that the terms finally agreed are less onerous than those originally proposed.

Iron Ore Resources

Following on the publication of an article in last month's issue on the Imperial Mineral Resources Bureau's volumes dealing with the iron ore resources of the British Empire and of the world, the question has been raised by several correspondents as to the exact present and prospective value of the various deposits described in these reports. In particular one correspondent has questioned the policy of the inclusion of 5,000,000,000 tons of Carboniferous bedded ores in South Wales and Monmouth in the iron ore reserves of Great Britain. These inquiries raise the whole question of what is an ore and what is a reserve. No doubt the propensity of optimists in promoting circles to talk loosely on these matters makes it desirable to restrict the use of the words "ore" and "reserves" to material which is valuable commercially at the time

of writing; but, on the other hand, in discussing the subject in a wider and more comprehensive sense it would never do to ignore the existence of deposits which may prove to be of ultimate use for the extraction of metal. We take it that the primary object of the Bureau in collecting the information contained in these reports was to prepare a complete statement of all the work done in investigating iron ore occurrences throughout the world, whether the deposits are commercially valuable at present or not. In the detailed accounts the present or prospective applications are clearly set forth from the point of view of the extent and nature of the deposits, the local demand for iron, and the chances of shipment to other countries, so that an intelligent reader is able to appraise their value. In the case of the iron deposits in the South Wales coal measures their inclusion in the tabulated statement of reserves may seem surprising, but the explanation of the figures in the accompanying text is adequate. It is shown that these deposits were the original basis of the South Wales iron and steel industry, and that, on the exhaustion of the richer parts easily mined, and on the import of cheaper and richer ores, their application waned and finally ceased; but enormous quantities still lie intact, and in the preparation of an estimate of possible future resources it would be impossible to ignore their existence.

In reading the various volumes constituting the report, the wide distribution of iron deposits of considerable magnitude is impressive. From the nature and extent of these deposits it is deducible that in future generations the manufacture of iron will be decentralized once more, though the control may, on the other hand, tend in the opposite direction, or the apportionment of work may be amicably distributed. At the present time there is plenty of demand for steel in various parts of the world at places where there are local supplies of ore, but the conditions of manufacture inhibit small-scale operations, with the result that the benefits are missed. In other places, as Nigeria and West Australia, there are big deposits of high-class ore, with no community to benefit by them, and no facilities for mining and transport. At the present time, outside Europe and the United States, the position is largely ruled by production in India and Manchuria. In Australia, the deposits owned by the Broken Hill Proprietary cannot be worked on account of the stubbornness of labour, and the resources at the disposal of the Queensland community lie fallow because of the strange views on economics held by the Government. A limited amount of smelting will be possible in South Africa. Increasing amounts of iron ore are being shipped from Brazil to the United States, and efforts are made from time to time to establish an iron and steel industry in British Columbia and to expand operations in Ontario. In the present issue particulars are given of African iron ore deposits, and in succeeding issues we intend to deal with the resources of other parts of the world. It may be urged that the MAGAZINE should not concern itself too much with iron ores; but it must be remembered that iron and steel dominate the metallurgical industry, and to that extent control the demand for all other metals and for most non-metallic minerals. Thus it is advisable for all mining engineers to have a notion of the mainsprings of the iron industry of the world.

Man as a Geological Agent

How far human agency affects the structure of the earth and brings about geological changes is a problem which most engineers have pondered over from time to time, and here and there writings are to be found in which the idea is suggested or tentatively discussed. It has been left, however, to Dr. R. L. Sherlock, a member of the Geological Survey, to present the subject in connected form and to provide some quantitative estimates of the results of human interference. His book "Man as a Geological Agent" * contains a vast amount of information collected chiefly in the British Isles, and not only does the author suggest many ways in which man exercises a geological influence but he gives statistical details indicating its probable extent. A consideration of these problems based on the book and on the experiences of the average mining man affords a useful mental occupation in these dull days.

To the readers of the MAGAZINE the activities of man in connection with mining and quarrying operations naturally come uppermost in their estimation. Many of these operations may baulk the geologists of

* "Man as a Geological Agent." Price 20s. net. London: H. F. & G. Witherby.

future ages and confuse their interpretation of evidence current in their time. This reflection has undoubtedly some bearing on present day speculations and prompts an examination into possible causes of land growth or tectonic action other than those based on physical laws. Instances of human building and excavation readily occur to the mining man. Mountains are levelled for the production of slate, building stones, and copper and iron ores ; clay deposits of various kinds are dug for brick and cement manufacture ; shallow beds of iron ore are removed by open-cut and the soil restored to its original position ; salt deposits are brought to the surface as brine, and the superincumbent strata collapse with important physiographic effects on the surface of the land ; in placer mining much of the ground has been shifted into streams and carried to known or unknown destinations to build up new deposits. In underground mining operations cavities have been left which may puzzle far-distant generations of investigators ; tailings and other materials are used for filling cavities and the new lode structure may mislead future geologists ; immense heaps of tailings, slag, and coal waste substantially alter the geological landscape ; operations at depth cause slides, falls, and other movements which affect the surface and the structure below. It may be carrying the idea too far to prophesy that the steamers and warships sunk in our waters will give rise to deposits of iron compounds in limestones or chalks of succeeding ages, but the result is not impossible. Scores of other cases will readily occur to mining men, so nothing further need be said on this head.

The agency of man in earth movements is seen in many branches of civil engineering, such as river dredging, harbour construction, irrigation, and railway and canal building. Irrigation probably changes the face of the earth more than any other venture of this kind. The protection of coasts from erosion and the reclamation of mud flats covered by the sea at high tide also have important influences on ultimate geological structure. Many of man's destructive ingenuities exercise profound influence on the surface of the earth. The razing of cities and territories in warfare, and the reckless felling of trees, both have under certain conditions the effect of converting fertile country into deserts ; and, contrariwise, sandy tracts may be altered by the judicious planting of trees and other vegetation. The uncontrolled removal of sand and shingle from the foreshores also partakes of the nature of destructive agency, not merely as an act of removal but even more so from the point of view of the eventual consequences arising from the alteration of the course of the sea currents.

Perhaps one of the most interesting examples of human agency is the growth of the surface or of " made ground " in cities or similar large communities. Inorganic material is imported to these centres for building construction, for foundations, for paving, for fuel, and as a constituent of food. All these eventually decay or disappear from their original condition, and the remains and residues accumulate. London presents an excellent example of this gradual growth of land, and even a casual examination of excavations for new buildings shows how much higher the present land surface stands with regard to sea level than the original surface of the marshy ground on which most of London has been built. At the present time thousands and millions of tons of builders' debris and other waste rubbish is being dumped on low-lying lands in the suburbs, and many geological surprises await the occupiers of houses built subsequently on this land when they proceed to lay out their gardens. A particularly interesting instance of ground consisting of accumulations is provided by the excavations in Fetter Lane undertaken by a mining engineer known to many of our readers, Mr. Hugh S. Gordon. Mr. Gordon lives in a flat nearby, and during the period of food scarcity towards the end of the war, cultivated a piece of unoccupied ground, which awaits the erection of new buildings, at the corner of Fetter Lane and Nevill's Court. On proceeding with the necessary deep digging he made many discoveries of antiquities of so attractive a nature that he undertook systematic excavation by open-cut, shafts, and tunnels. By careful examination he was able to classify the pottery, coins, implements, ornaments, etc., into their historical eras, and to ascertain the rate of growth of the land from bedrock in Roman times through the succeeding centuries.

We have wandered away considerably from the actual contents of Dr. Sherlock's book, and have given our own impressions of the subject rather than quotations from the author. Readers will find the book most fascinating, and one in which the geological theories are founded on ascertained facts rather than on surmise.

REVIEW OF MINING

Introductory.—Though affairs are still dull, there are many signs of improvement in the near future. Iron and steel production in this country is increasing, and the lead, tin, and zinc markets are hardening. The better conditions on the Rand are having a helpful influence. At one time the trouble between Greece and Turkey threatened to stir up the dying embers of the Great War, but better counsels are now prevailing, and business circles are consequently less ruffled than they were a fortnight ago. The rejection of the Russo-Asiatic agreement by the Soviet Government is, of course, disappointing, but the statement issued indicates that those in power are showing some desire to get back to modern economics and to international relationships.

Transvaal.—The information contained in the yearly reports of several mines on the Rand, quoted elsewhere in this issue, indicates that costs have come down sufficiently to make it possible for comparatively low-grade mines to make a profit with gold at par. The improved position is also reflected in the announcement by the General Mining and Finance Corporation that the West Rand Consolidated is earning sufficient profit to increase its development, and that the re-financing of the Cinderella is now within the range of possibility. Speaking at the quarterly meeting of the Transvaal Chamber of Mines, Sir Evelyn Wallers reported a vast improvement in working efficiency arising from the elimination of the continual petty disputes that used to cause so much worry to the managers.

The report of the Modderfontein East for the year ended June 30 is quoted elsewhere in this issue. This report shows that developments in No. 1 Cloverfield shaft have been good, though opportunities for this work have been restricted owing to delay in the delivery of plant. On the other hand, the results in the lease area served by Nos. 2 and 3 shafts have been disappointing, as the ore disclosed is of medium to low grade. Since the close of the company's year it has been announced that development and stoping in the lease area have been suspended for a time, and that operations are being pushed in the Cloverfield section. The object of this new policy is to earn sufficient profit to pay off the company's debenture debt. Afterwards it will be possible to raise the necessary capital to erect the plant purchased from the Simmer Deep-Jupiter, and therewith to treat the large amount of ore of low and medium grade developed in the lease area.

Diamonds.—During the last few months there has been much talk of improvements in the diamond market, but so far the producing companies have not deemed it prudent to resume output on any important scale. The chief favourable items of news are the payment of a dividend by the New Jagersfontein and a decision on the part of the Consolidated Diamond Mines of South-West Africa to increase its rate of output. There are, however, no signs yet of De Beers and Premier resuming commercial production.

Rhodesia.—The output of gold during August is reported at 56,037 oz., as compared with 54,191 oz. in July, and 53,200 oz. in August, 1921. Other returns for Southern Rhodesia for August were : — Silver, 14,196 oz. ; coal, 49,465 tons ; chrome ore, 973 tons ; copper, 278 tons ; asbestos, 1,712 tons ; arsenic, 23 tons ; mica, 3 tons ; diamonds, 15 carats.

The Rhodesia Gold Mining & Investment Co. announces that the ore at the Huntsman mine is exhausted and that prospects do not justify further expenditure. All mining has therefore been stopped.

It will be remembered that toward the end of last year Mr. Stanley Edwards captured the control of the Gaika Gold Mining Co. from the Gold Fields Rhodesian Development Co. The first yearly report under the new regime was issued this month. From this it appears that the directors contemplate a return of capital amounting to £70,000, equal to 5s. per £1 share, the distribution to be made out of accumulated funds now invested in Government securities and in Rand mining shares. The prospecting and development work has not been attended with any important success. The reserve is estimated at 46,671 tons averaging 13·6 dwt. per ton, of which 30,404 tons averaging 14·1 dwt. is available for stoping. There are also quantities of ore of lower grade. During the year ended June 30 covered by the present report, 48,414 tons of ore was treated, from which 12,102 oz. was extracted by amalgamation and 6,288 oz. by cyanide. The net profit was £26,642, out of which £20,512 has been paid as dividend, being at the rate of $7\frac{1}{2}\%$. The present policy is to mill 4,000 tons per month averaging 9·5 dwt. per ton.

Nigeria.—The directors of the Naraguta (Nigeria) Tin Mines, Ltd., have issued a report by their engineer, Mr. F. O'D. Bourke, on the Birnin Gwari gold areas. As already recorded, a 3-stamp mill, boiler, engine, and pump were erected early this year. Milling was at once started on the ore that had been raised from the "A" shaft. A new shaft known as the "Yelwa" has been started west of the "A" shaft, and it is to be sunk to 200 ft. A cross-cut has been driven at 48 ft. from the new shaft to the workings between the "A" and "B" shafts, and the lode as disclosed has been sampled. The sampling shows varying results, both as to the extent of the deposits and the gold content, and further work is to be undertaken with a view to more complete prospecting of the lodes.

Australia.—Labour troubles continue. At the Broken Hill steel works, the few men remaining at work threaten to strike in opposition to an increase in the weekly hours from 44 to 48. The Mount Lyell Co. has talked of closing down owing to the engineers refusing to accept the 48-hour week. The coalfields of New South Wales will probably be closed for the same reason. On the other hand a few of the unions have decided not to strike on this subject. In South Australia the Government proposal to abolish compulsory arbitration has led to much wild talk in certain circles about direct action as a labour weapon.

Following on the announcement made by Mr. W. H. Woodhead, as quoted in the August issue, the British Broken Hill Co. has made application in the Australian Courts asking that the company's agreement with the Broken Hill Associated Smelters Co. for the treatment of its lead ore and concentrates should be declared invalid.

India.—Rock movements continue to give trouble at the Champion Reef gold mine. On September 19 a rock-burst occurred between the 54th and 56th levels in Glen shaft, and 100 ft. of the shaft was choked. Two days afterward a rock-burst occurred at the 40th level north from Garland's shaft. Nos. 40 and 41 levels were choked and the 39th and 42nd damaged.

In the MAGAZINE for January last, Mr. Ernest Parsons gave a comprehensive account of the great iron ore deposits in the Singhbhum, Keonjhar, and Mayurbhanj districts in the State of Bihar and Orissa. In this connexion it is of interest to record that the report by Mr. H. C. Jones, of the Indian Geological Survey, just to hand, contains an estimate of the proved ores in these districts at 2,832,000,000 tons. Extensive sampling of these ores gives an average of 63 to 64·3% iron, 0·015 to 0·03% sulphur, 0·058 to 0·088% phosphorus, with traces of manganese and titanium. The ore may be classed as high-grade hematite.

Malaya.—The dredge at Pengkalen started work in August, and during that month 12 tons of tin concentrate was won. At the Tekka-Taiping the output is low at present, for No. 1 dredge is being overhauled, and the new dredge is occupied in opening out the working face and digging down to the required depth.

Siam.—It will be remembered that at the beginning of 1920 the Siamese Tin Co. floated a subsidiary, the Bangrin Tin Dredging Co., to acquire alluvial tin property in the province of Renong, Western Siamese States. The report of the Bangrin Co., now published, states that there have been many delays in building the dredge. The first shipment of parts was made in October, 1921, and the pontoon has been built and floated, but it is still impossible to give a definite date for the completion of the dredge.

Cornwall.—References to the scheme whereby the Government will grant financial aid to Dolcoath are made in our editorial columns, and our Camborne correspondent reports progress at the other two mines, Levant and South Crofty, where work has been rendered possible by the Government guarantee of loans.

The yearly report of Kingsdown (Hewas Water) Tin Mines announces that mining and milling will be commenced early next year. The Poldice plant, consisting of 30 stamps and concentrators, has been purchased, and it is now in course of re-erection close to the company's main shaft. Development has proved eight parallel lodes within 600 ft. of the shaft, and four of these have been prepared for stoping from the 40 ft. to the 300 ft. level. The adjoining Little Ventonwyn property has been leased after cross-cuts had proved the continuation of the lodes into this ground. The report by Mr. R. F. Allen, the general manager, contains details of the lodes at various points throughout the property, and gives particulars of comparatively rich ore disclosed in the rises between the levels.

Scotland.—The nickel works at Kirkintilloch, near Glasgow, owned by the French

company, La Société le Nickel, are to be closed after having been in operation for forty years. The ore was brought from New Caledonia in sailing ships to be smelted at these works. Owing to the virtual cessation in the production of armaments, the demand for nickel has decreased substantially, so the business in Scotland is to be discontinued in future ; smelting is to be done at the mines.

Derbyshire. — As foreshadowed last month, the Consolidated Gold Fields has acquired the Mill Close lead mine. This mine was fully described in the MAGAZINE for April, 1917.

Canada. — The B.C. Silver Mines Co., owning property adjoining the Premier gold-silver mine in northern British Columbia, is progressing with development, and the first report to be officially issued in London by the Selukwe Gold Mining & Finance Co., the owner of the shares of the B.C. Silver Mines, was circulated on September 29. In this report Mr. C. A. Banks, the manager, states that the tunnel has been driven 232 ft., and that No. 3 bore-hole has been driven 805 ft. The drill has passed through heavily mineralized country containing iron and lead sulphides with low silver contents. The lode has not yet been reached.

The directors of the Kirkland Lake Proprietary are contemplating the sale of the property to an American group, and ask shareholders for an endorsement of this policy. The name of the American group is not disclosed nor are the terms, so any decision on the part of the shareholders partakes of the nature of a step in the dark. The directors, however, urge the acceptance of their proposal, as by this means working capital will be secured on a liberal scale from parties who stipulate for a local company free from British income tax demands.

Last April we recorded the formation of a Canadian company to acquire and develop the Davidson property at Porcupine. It appears that the money then received is not sufficient for the programme of shaft sinking, prospecting, development, and provision of metallurgical plant. At an informal meeting of shareholders held in London on the 1st inst., the controller, Sir Archibald Mitchelson, announced that a loan for £100,000 had been secured for the object of completing the programme. During the last six months operations have been centred on diamond-drilling from the present bottom working at 600 ft. A number of holes have been sunk with encouraging results, but the general position remains obscure to the outsider. A new shaft is now to be sunk and more development undertaken.

Mexico.—The Consolidated Gold Fields of South Africa is interested in a scheme for consolidating the Compania Metalurgica Mexicana, the Compania Minera Nazareno y Catasillas, and the Compania Minera La Constancia, companies which own extensive lead and copper properties, with smelters at San Luis Potosi, Concepcion, and Saltillo. These companies are desirous that the Mazapil Copper Co., whose offices are in Manchester, should join in the consolidation, and the Consolidated Gold Fields has made an offer to the Mazapil board for the purchase of the properties on the basis of payments equivalent to 35s. per share. This offer was declined, because the directors consider that things are going perfectly satisfactorily for the company. The Gold Fields has therefore approached shareholders direct with the object of acquiring options on the shares which will secure the control of the company by purchase. The present position is that the directors have advised shareholders not to give the options.

Colombia.—The commissioning of the second dredge of the British Platinum and Gold Corporation has been delayed by weather conditions. Its completion was stopped on several occasions by dangerous floods, and when it was ready for work a drought was experienced, and it could not be floated. Eventually during the floods occurring usually in October the launching became possible.

Russia.—As briefly recorded last month, Mr. Leslie Urquhart was successful in coming to an agreement with M. Krassin for the return of the mining properties to the Russo-Asiatic Consolidated, the final word, of course, being with the Soviet Government. After discussing the matter for over a month, Lenin and the Council of Commissars have refused to ratify this agreement, alleging that, though they are desirous of the help of the Russo-Asiatic, they could enter into no agreement with an English company until the British Government recognized the Soviet Government and gave Russia a voice in the settlement of the Eastern question. This decision is naturally disappointing, but it must be said that, though the negotiations have failed for the present, the attitude of those in power in Russia is clearly very different from what it was six months ago, and that the outlook is substantially brighter.

THE DISTRIBUTION AND GENESIS OF LEAD AND ASSOCIATED ORES IN WESTERN SHROPSHIRE

By T. C. F. HALL, M.Inst.M.M., F.G.S.

INTRODUCTORY.—The recent appearance of the Geological Survey Memoir dealing with the mining district of Western Shropshire, and the extensive extracts from that Memoir given in the "Mining Digest" of the MAGAZINE for April last, have directed attention to the ore occurrences of that region. Since, however, the official publication is concerned mainly with the actual occurrence and mining of the deposits, rather than with their origin, an account of the conditions governing the distribution of the ores in relation to the problems of their genesis may be considered a suitable continuation to the information already published.

The present writer was engaged by the Shropshire Mines, Ltd., whose operations extend over the greater part of the mining area, to make an examination of the geological features of the district in relation to the nature and distribution of the ores. The results of this work, which entailed the making of a six-inch geological map, were communicated to the company in a private report in March, 1919. That report was later passed to the Geological Survey, and considerable portions of it, together with reductions of a part of the map and the sections, have been incorporated in the official Memoir and need not be repeated here. The following remarks present the writer's conclusions concerning the genesis of the ores based upon a study of the conditions governing their occurrence and distribution.

The ores, comprising those of lead, zinc, copper, and barium, occur principally in or in close association with a series of fissures trending N.W.-S.E. and E.N.E.-W.S.W. These directions are subject to some variation, but they represent the main lines of fracturing which influenced the flow of the metal-bearing solutions and determined the positions of the resultant mineral veins. Subsidiary occurrences of ore occupy spaces between bedding planes, produced by differential movement of the strata during folding.

Since 1845, the first year for which official statistics are available, this district has produced approximately 250,000 tons of lead concentrate, 20,000 tons of zinc concentrate, and 300,000 tons of barytes, together with a small amount of copper ore. Previously, although no reliable statistics are procurable, there must have been a considerable production of lead ore, since its mining dates back to Roman times. Zinc ore was first recorded in 1858 and barytes in 1860.

GENERAL GEOLOGY.—The area is composed of a series of Cambro-Ordovician strata in

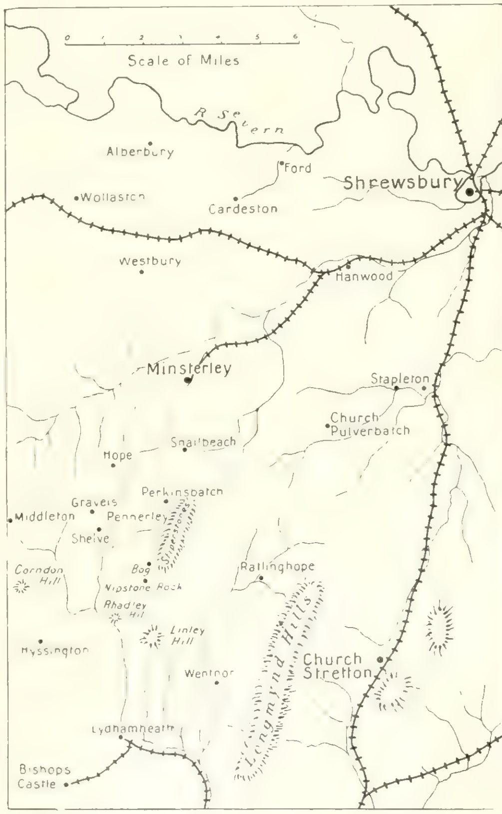

FIG. 1.—MAP OF WEST SHROPSHIRE.

conformable sequence, having a general north-easterly strike and north-westerly dip, faulted at their base against the Pre-Cambrian rocks of the Longmynd area, and overlain unconformably by Silurian strata of Upper Llandovery age.

The distribution of these strata in the main area of mineralization may be seen on the map published in the Survey Memoir. Attention may here be directed to an error in

the drawing of this map. The narrow strip left blank in the lower right-hand corner of the figure, between the Hope shales and the Stiperstones quartzite, is part of the Mytton beds and should, therefore, be stippled. This map is reproduced in Fig. 3, p. 203, with the alteration made.

The accompanying section (Fig. 2.) gives a diagrammatic representation of the geological sequence across the district, roughly from west to east. This brings out the folding of the Lower Ordovician rocks, and the regular westerly dip of the Middle and Upper divisions, but faulting and local irregularities have been omitted in the generalization. The sub-divisions are those recognized and described by the late Professor Lapworth. (See "Proceedings Geological Association," Vol. XIII (1893-4), pp. 311-19, and "Summary of Progress of the Geological Survey" for 1915.)

The main ore-bearing horizon is furnished by the Mytton beds, which immediately overlie the Stiperstones quartzite and are succeeded by the Hope shales. These beds have yielded commercial deposits of lead and zinc ores, with accompanying barytes. Higher in the sequence no important lead-bearing deposits have been located, but barytes occurs at several horizons, and has been extensively worked in the Stapeley ashes at Cliffdale and in the Hagley and Whittery ashes at the top of the sequence, adjacent to the Silurian cover. Here the largest deposit of high-grade barytes known in the district was for many years worked at Wotherton.

To the east of the Stiperstones considerable quantities of barytes and small amounts of copper ore have been mined in the Pre-Cambrian grits of the Longmynd district.

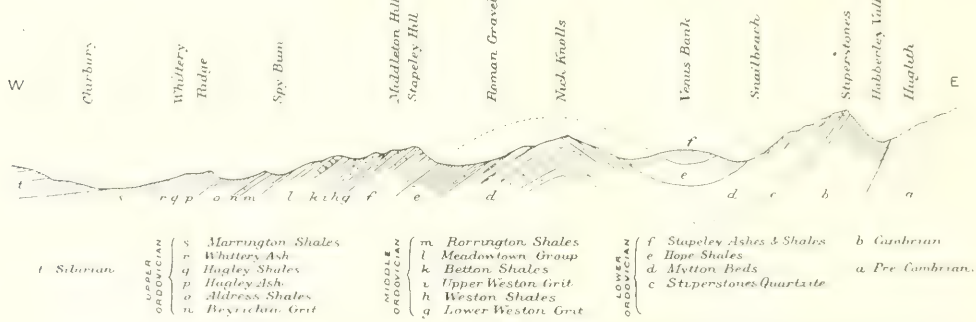

FIG. 2.—SKETCH SECTION ACROSS THE DISTRICT TO SHOW THE GEOLOGICAL SEQUENCE.

A very marked physical feature is furnished by the Stiperstones quartzite which forms the base of the Ordovician sequence. Owing to its hard and resistant character this rock forms a high ridge and is readily distinguishable. Special allusion is made to this important feature since it so happens that it forms an easily recognized divisional line between two very distinct metalliferous areas, namely, that occupied by the lead and zinc bearing Ordovician strata on the west, and that of the copper bearing Pre-Cambrian (Longmyndian) strata on the east.

The Ordovician rocks consist principally of an alternating series of grits and shales, with intercalated volcanic material and intrusive diabase, and the occurrence of ore has an intimate relationship to the lithological nature of the enclosing strata. Thus, the shales are everywhere quite barren, and mineralization is confined mainly to the grits and, to a less extent, the volcanic ashes.

The existing geological structure of the area is the outcome of repeated folding, faulting, and denudation due to successive earth movements, and the history of the mineralization is intimately bound up with that of these changes.

One of the most pronounced geological features of the district is the large fault which separates the Pre-Cambrian strata of the Longmynd from the newer rocks to the west. This represents a considerable displacement of the strata, and has doubtless been a line of disturbance at successive periods. It now separates two very distinct ore-bearing horizons. The adjacent Cambrian shales are conformably succeeded by the Ordovician strata, and the whole form an uninterrupted sequence up to the unconformable base of the overlying Silurian.

FISSURING.—In late Ordovician or early Silurian (Lower Llandovery) times the Ordovician rocks were subjected to earth movement, accompanied by folding and

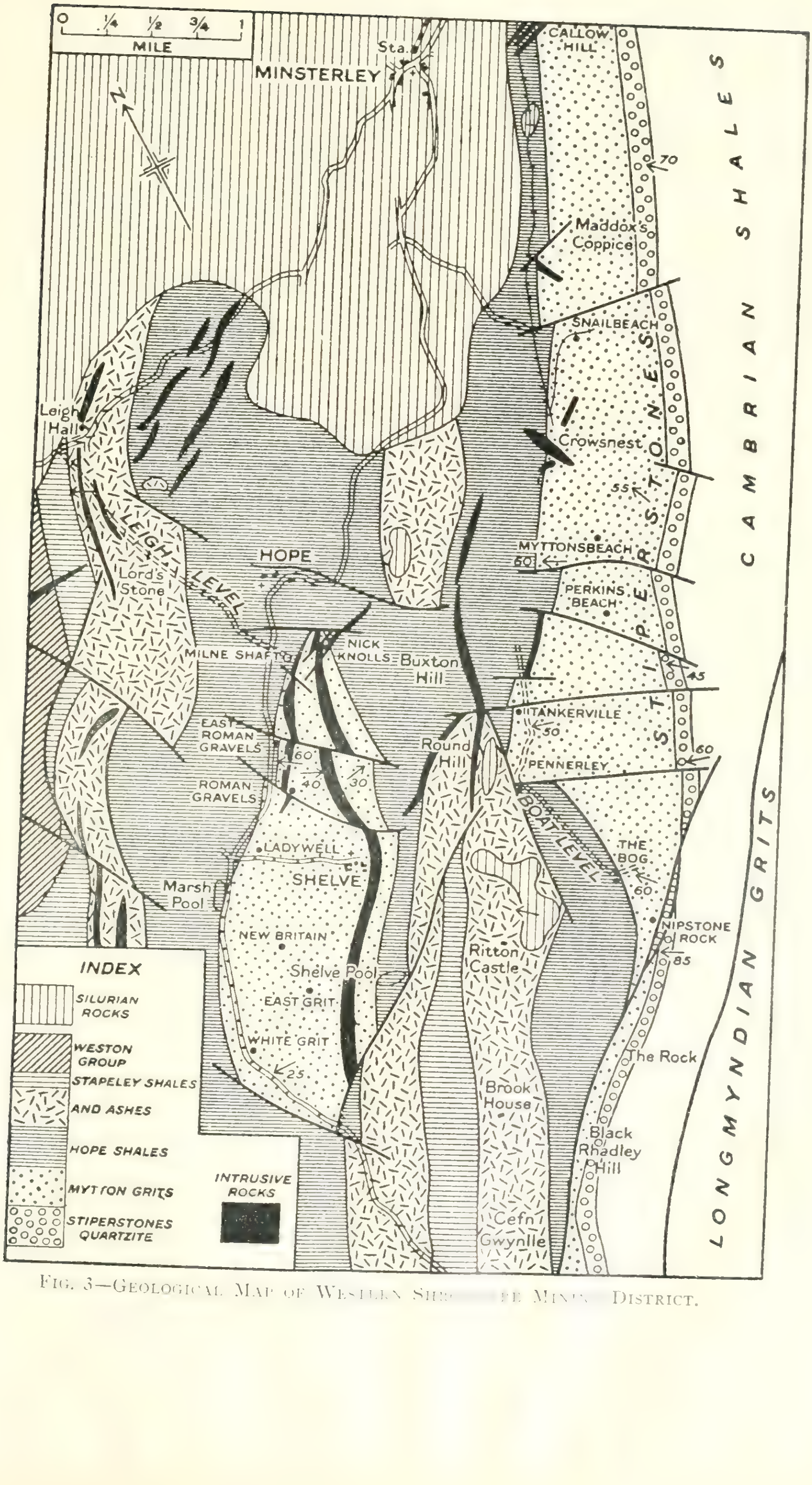

FIG. 3—GEOLOGICAL MAP OF WESTERN SHR[illegible] MINING DISTRICT.

fracturing, and it was upon their upturned and denuded edges that the succeeding Silurian strata (Upper Llandovery) were laid down. To these post-Ordovician disturbances are due the north-north-easterly folds and strike faults and the majority of the igneous intrusions, all of which are anterior in formation to the period of mineralization. The north-westerly and east-north-easterly fractures, with their accompanying dykes, on the other hand, are quite independent of the pre-Silurian folding, which they intersect at a high angle, and are evidently younger, for though they do not, except in one demonstrable case, penetrate the Silurian strata, there is good reason to suppose that they are the result of the earth movements which at the close of Silurian and the beginning of Devonian times so profoundly affected large parts of the British Isles. The effect of these movements (Caledonian System) on the Silurian strata of this neighbourhood is seen in the pronounced north-easterly strike, so well displayed in the Long Mountain syncline to the north-west, and in the Ludlow-Wenlock area east of the Longmynd. It follows that these movements must have acted upon both the Silurian and the underlying Ordovician rocks, though it can be readily conceived that the effects produced may have been very different. Thus, while the former, being previously undisturbed, would readily lend themselves to simple folding, the latter, having already had one set of structures impressed upon them, would tend to resist any futher adjustment, with the consequence that stresses would be set up resulting in fracturing across the earlier folds. A co-ordinated system of fissures oblique to the general strike of the rocks was thus produced, into which material derived from deep-seated igneous activity connected with the movements found its way and formed the mineral veins. This system of fracturing, regarded as due to compressive stresses, is a type well recognized in many mining districts. Both sets must have been formed concurrently, and they often intersect without any relative displacement, as at the Bog Mine and elsewhere. At Snailbeach Mine, however, the main vein, which occupies an east-north-easterly fissure, is deflected by a north-westerly fracture.

Both series are mineralized, but more especially the east-north-easterly ones, which constitute most of the principal veins of the district, such as the Ryder vein of the Grit and Pennerley Mines, the Big Spar vein of Perkins Beach Mine, and the Main veins of the Bog and Snailbeach Mines. The north-west fissures are represented principally by the Roman vein of Roman Gravels Mine, and the Wood vein of the East Roman Gravels Mine.

The former show little relative displacement of the walls, and do not therefore materially affect the geological structure. In fact, were it not for their extensive mineralization they would doubtless in most cases escape attention during mapping. The north-westerly fractures, on the other hand, have frequently experienced considerable movement and are readily recognized by the abrupt termination of the strata against them. It appears, therefore, that adjustments along the fractures after their formation followed principally a north-westerly direction. The movements must have taken place previous to mineralization, as no case has been recorded where the vein filling of a displaced fracture is faulted out ; so far as observation goes, it always continues along the plane of junction of the two fissures.

These fissures are best developed in the harder beds, such as the Mytton grits, Stapeley ashes, etc., and tend to die out or lose their individuality in the soft shales. Such beds under the stress of earth movement would experience an ill-defined fracturing, and any spaces formed would be liable to become filled or "pugged" by crushed material readily broken from the walls. To this absence of well-defined planes of fracture which could serve as suitable circulation channels for ore solutions may be attributed the non-productiveness of these rocks.

Associated Igneous Rocks. — The abundant intrusive rocks which are found throughout the district are of basic composition and belong, with few exceptions, to the group of diabases or dolerites. They occur in the form of laccolites, sills, or dykes. Although they show no close genetic relationship with the mineral veins and, as already stated, were chiefly formed long anterior to the period of mineralization, there are certain long, narrow dykes, having an east-north-easterly trend and obviously younger than the main intrusions, which show a close similarity in occurrence to the mineral veins. They are often found in contact with the veins for long distances, seemingly occupying the same fissures. This association occurs

in the case of the Ryder vein at Pennerley and the Grit Mines; the Whitestone or North vein at the Bog Mine; at Cliffdale Mine; at Resting Hill, south of Snailbeach; and at Callow Hill. Most of these examples are now covered up and cannot be examined, but at Callow Hill the relations can be well observed in the underground workings which are still open. Here the dyke is in contact with the vein only in part of its course, and is otherwise quite normal and unaltered. In the neighbourhood of the junction, however, it undergoes a change, and at the place of contact is in a state of profound alteration, which causes the rock to assume a whitish or pale grey colour and to lose much of its hardness and coherency. A microscopic examination of the altered rock shows the chief modification to consist in the breakdown of the original felspar to a white powdery substance of a micaceous nature, and the change is that known as sericitization.

Specimens of a similar nature may be gathered from the dumps at the Bog Mine, and Morton in his paper on "The Mineral Veins of Shelve" (see "Proc. of Liverpool Geol. Soc.," 1869), speaks of a white "comb" projecting above the surface at the Grit and Bog Mines. It seems, therefore, that in all cases where dykes and veins are in contact we should find, could we examine them, that this alteration is a constant feature, and it furnishes an explanation of the terms "whiterock vein" or "whitestone-vein" so often used in the district by the old miners. Moreover, a knowledge of this fact possesses considerable significance as bearing upon the possible location of otherwise hidden ore-bodies.

The chemical nature of this alteration may be seen from the analyses in the table in the preceding column which show the compositions of a typical unaltered diabase of the district, and of the altered rock in contact with the vein at Callow Hill.

TABLE OF ANALYSES OF DIABASES.

	Unaltered Diabase, Shelve Hill.	Altered Diabase (Whiterock), Callow Hill.
SiO_2	50·53	62·91
TiO_2	1·74	3·39
Al_2O_3	14·50	21·15
Fe_2O_3	0·13	0·06
FeO	8·65	1·53
MnO	0·96	0·13
CaO	9·76	0·46
BaO	nt. fd.	nt. fd.
MgO	7·70	0·11
K_2O	0·16	0·82
Na_2O	2·44	2·52
Li_2O	nt. fd.	trace.
H_2O at 105° C.	0·56	0·87
H_2O above 105° C.	2·02	5·40
P_2O_5	0·16	0·21
FeS_2	0·40	0·49
CO_2	0·58	0·10
	100·29	100·15

(Analyses by E. G. Radley.)

This evidence conclusively proves that the dykes are of earlier formation than the mineral veins, and occupied the fissures prior to their invasion by the metal-bearing solutions which so markedly affected them. It appears, however, that they may be referred to the same causes and are the result of igneous activity accompanying the Caledonian disturbances, which are regarded as responsible for the formation of the fissures. Into these fissures igneous material, now represented by the dykes, first found its way. But this phase of intrusion does not seem to have been of any great extent, and the chief period of fissure-filling appears to have been reserved until later, when the material from which the mineral veins were formed was being expelled from the underground reservoirs.

THE MINERAL VEINS.—The mineralization of the post-Silurian fractures, to which the formation of the veins is due, was evidently connected with the ascent of magmatic solutions emanating from deep-seated igneous intrusions during a period of crustal disturbance. Although, as previously stated, the veins show no close genetic relationship with any of the exposed igneous intrusions, it is highly probable that they are connected with a concealed granite mass. In many areas affected by the Caledonian movements the accompanying igneous activity is represented by intrusions of granite, and similar rocks doubtless exist in this district, though concealed under the overlying strata. In Wicklow, the Isle of Man, the Lake District, and Scotland lead-bearing veins are found in close association with these granite masses, suggesting a genetic relationship, and we may reasonably suppose a similar association here though denudation has not proceeded sufficiently far to reveal it. In this district we have only an earlier, basic, phase of intrusion visibly present. These dykes may be regarded as representing an early expulsion from the parent magma which later consolidated as granite; the formation of the mineral veins was connected with the last phase of consolidation.

As already stated, it is considered that the

formation of the fissures took place during the Caledonian disturbances which affected the district in post-Silurian times. Not only may the fissuring of the district be attributed to these movements, but it is also reasonable to suppose that the deposition of the ores may be traced to the same causes and that it was a result of igneous activity accompanying the disturbances. Metal-bearing solutions emanating from deep-seated intrusions during cooling would find a ready exit along the fractures then formed, and during their upward passage the mineral contents would be thrown out of solution with fall of temperature.

Fissuring and mineralization must have been closely connected, since free channels of circulation could only be furnished by recently formed fractures. Fractures of earlier date would most likely be sealed up, and would offer, therefore, no ready passage to the solutions. For this reason it is not anticipated that a search for ore in the pre-Silurian fractures is likely to meet with any success. On the other hand, spaces formed between bedding planes by the differential movement of the strata during folding were sometimes the receptacles of ore, and this mode of occurrence is well seen along the bedding planes at the junction of the Stiperstones quartzite and Mytton beds, south of the Bog Mine. The so-called parallel veins which, according to old plans, run diagonally across the Ryder vein in the Pennerley Mine would also appear to be of this nature, and there is little doubt that throughout the district this infiltration of material into suitable spaces bordering the main lines of mineralization has led to a false conception of the number of true veins.

Genesis and Distribution of the Ores.—From the foregoing it will be gathered that the genesis of the ores is attributed to magmatic solutions emanating from deep-seated intrusions during a period of crustal disturbance connected with the Caledonian movements, which affected the district in post-Silurian times. The occurrence, in other parts of the British Isles, of granite masses of Caledonian age suggests a similar presence in this district, the rocks being still concealed at some depth below the surface.

With the exception of the barytes deposits in the Pre-Cambrian strata, which have been formed by a rearrangement of previously deposited material, there is no evidence that the ores are of superficial origin. Their manner of occurrence, vertical distribution, and physical characters all favour the assumption of a deep-seated formation. On the other hand, this conclusion must not be taken as implying a more or less indefinite continuation in depth, for there must have been particular conditions of temperature and pressure controlling ore-formation, and deposition was closely dependent upon the characters of the country rocks adjacent to the fissures. The distribution of the ores, therefore, must be considered in relation to these various factors, and by so doing a fairly definite range can be established.

The relative distribution of the several ores is a result of their different solubilities at successive temperatures during the cooling of the solutions accompanying their upward passage. The limitation of different metals, in deposits carrying a number of ores, to more or less well-defined zones has been established in many mining districts, and the conditions attending deposition at different horizons have been investigated in considerable detail, especially by American geologists. It has been shown, for example, that the sequence of deposition from solutions containing tin, copper, zinc, and lead takes place in the following order, with the formation of a series of easily recognizable zones, though their definition is necessarily subject to a certain degree of overlapping :—

(1) A deep zone carrying tin and some copper.

(2) An intermediate zone of chiefly copper.

(3) An upper zone containing chiefly zinc and lead, the deposition of the former metal being in advance of the latter. Barytes, also, is formed in this zone.

In this district, the first-named zone is not represented at the surface, though it may possibly exist at considerable depth. Of the latter, the copper zone is found in the Pre-Cambrian rocks on the east of the Stiperstones, while the lead-zinc-barytes zone is confined to the Ordovician rocks on the west of that feature. Only insignificant amounts of lead ore have been encountered in the Pre-Cambrian area, while the occurrences of copper in the lead-bearing veins of the Ordovician rocks are likewise unimportant, being of the nature of small and impersistent stringers. It is evident, therefore, that we are dealing with deposits which represent different zones of mineralization, formed at different horizons. A study of the geological

relationship of the two areas shows that they are separated by a pronounced fault which represents a considerable displacement of the strata, and as already suggested, has doubtless experienced repeated disturbance. It may be safely assumed, therefore, that the relative positions of the zones have undergone considerable modification since the period of mineralization.

The accompanying diagram (Fig. 4) is intended to illustrate the conditions supposedly existing at the time of mineralization. It is considered that at that time the Cambro-Ordovician strata occupied a higher position relatively to the Pre-Cambrian rocks than they do now, and that these latter were then concealed at such a depth

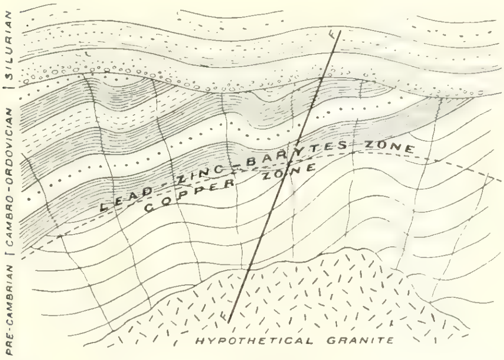

FIG. 4.—DIAGRAM TO ILLUSTRATE THE GEOLOGICAL CONDITIONS AT THE TIME OF MINERALIZATION.

Subsequent faulting along the line F–F has brought the lead-zinc-barytes zone of the Ordovician rocks alongside the copper zone of the Pre-Cambrian rocks, much of which, together with the overlying strata, have been removed by denudation.

that they were largely within the zone of copper deposition. The Ordovician rocks, on the other hand, received the mineralizing solutions at a temperature at which most of the copper had been extracted and the deposition of zinc, lead, and barytes was taking place. Subsequent faulting has brought the two zones into horizontal position, and the accompanying denudation has removed the lead-bearing rocks which formerly overlay the Pre-Cambrian strata to the east.

So far as the available evidence goes, therefore, we may conclude that the ore-bearing solutions deposited their copper content during their passage through the deep-seated Pre-Cambrian rocks, and that it was not until they entered the upper portion of those strata, or even the overlying Ordovician rocks that the temperature had fallen sufficiently to allow of the deposition of zinc, followed by lead. The barytes was one of the last minerals formed, so that its position in the veins is of the nature of a capping.

The extent of mineralization was controlled by the nature of the fissures to be traversed, the varying country rocks affording very different conditions in this respect. This influence was apparently entirely a physical one, and there seem to be no good grounds for supposing that chemical action played any important part. Thus, deposition must have been at a maximum in those rocks, which favoured the formation of clean, well-defined fractures, affording a free and easy circulation to the solutions, while retarded or opposed where the fracturing was ill-defined, as in shales. The latter, therefore, have a limiting effect upon the extent of mineralization, for the lack of suitable circulation channels would tend either to hold back the solutions or, in places where the hydrostatic pressure was sufficient to force a passage, the increased pressure would have the effect of raising their solvent power, thus delaying deposition until a more suitable environment was encountered.

These variations are well seen in the Cambro-Ordovician rocks. The Cambrian shales at the base of the sequence are quite unproductive, and the passage of the solutions through these rocks from the underlying Pre-Cambrian was evidently unaccompanied by ore-deposition. With the reduction of pressure accompanying the entry of the solutions into the freer channels of the overlying Mytton beds deposition became active, though here there are rich and poor zones of ore corresponding to the alternations of grit and shale bands. The succeeding Hope shales furnish another unproductive zone, and it is evident that ore deposition again failed here. Moreover, the nature of the ore occurrences at higher horizons suggests that these beds acted as a severe check to the further progress of the ore-bearing solutions so that the Mytton beds became the loci of maximum deposition in the lead-bearing zone. In certain favourable situations, however, the solutions worked their way to higher levels, but having already parted with the bulk of their lead, and almost certainly the whole of their zinc contents, contained principally barium. The practically pure barytes deposits of Weston and Wotherton Mines, and the sporadic occurrences of lead ore found in the Stapeley ashes at Ritton Castle and elsewhere, may

be thus accounted for, but the evidence shows that commercial deposits of lead and zinc are not to be generally anticipated above the horizon of the Mytton beds. These constitute, therefore, the chief ore-bearing zone of the district. The upper part of this zone is richest in lead, and this metal tends to be displaced by zinc at lower levels, while it is likely that there will be a general impoverishment in depth. The lower limit of the lead-zinc zone is furnished by the Stiperstones quartzite, and the underlying Cambrian shales are, as above stated, quite unproductive.

In the Pre-Cambrian rocks the exposed copper content is very disseminated in its occurrence, and gives evidence of having experienced considerable migration and dissipation in the porous country rocks. Secondary enrichment and concentration of the material have locally taken place, as at Westcott, where it was formerly mined, but on the whole it is widely diffused and holds out little encouragement for being worked. As we are dealing with a leached zone there is, of course, every possibility of meeting with richer and more defined deposits in depth, below the zone of oxidation, but so far as the nature of the exposed occurrences goes there is no evidence of the existence of any extensive bodies of ore.

The presence of barytes in association with the copper would appear to present an anomaly, since the formation of this material belongs to the last stage of mineralization and its primary deposition cannot have taken place, therefore, in the copper zone. An examination of the material, however, shows it to be markedly different from that occurring in the lead veins, and the distinction is so pronounced as to at once suggest a difference in origin. It is characterized by a pink colour, due to the presence of finely divided iron oxide, and is frequently intimately associated with quartz and mixed with brecciated fragments of the country rock ; its habit and appearance are totally distinct from that of the white crystalline barytes which occurs in the veins of the Ordovician rocks. The latter material is usually very pure and forms considerable masses with well-defined walls and no admixture of country rock. All the evidence favours the idea of a secondary origin for the barytes of the Pre-Cambrian rocks, and it is to be regarded as a re-deposition of material removed from the upper portions of the veins during the denudation of the overlying rocks. Its occurrence, therefore, is superficial in extent, and no great persistence in depth is to be expected.

Many of the lead veins of the district carry no barytes capping, and it seems likely that these belong to a slightly earlier period of mineralization than the others. As a general rule it may be taken that the veins having an easterly and westerly trend have a barytes capping, while those bearing north-west carry lead ore up to the surface and have little or no barytes content. The distribution of this mineral, however, is subject to much local variation, and veins carrying little or none may be found adjacent to others which have yielded it to a considerable depth with only a sprinkling of lead ore.

In many of the veins the barytes is stained black with bituminous matter and occurrences of a pitch-like substance in the veins have often been reported. This phenomenon is met with both in the veins of the Pre-Cambrian and of the Ordovician strata, but the fact that it is found principally in the northern portion of the area suggests that it may be attributed to the former presence of overlying Coal Measures, from which carbonaceous matter was derived by some process of distillation.

Summary of the History of Mineralization.—The main facts and deductions relating to the mineralization of the district may, for convenience of reference, be summarized as follows :—

The ores occur principally in, or in close association with, a series of fissures trending N.W.–S.E. and E.N.E.–W.S.W. These directions are subject to some variation, but they represent the main lines of fracturing which influenced the flow of the ore-bearing solutions and determined the positions of the resultant mineral veins. Subsidiary occurrences of ore occupy spaces between bedding planes, produced by differential movement of the strata during folding.

The formation and subsequent filling of the vein fissures were connected with the disturbances which affected the district in post-Silurian times. These disturbances, acting upon the resistant Ordovician and older rocks, found expression in the formation of two sets of fractures, approximately at right angles, and along these the ore-bearing solutions travelled from deep-seated sources.

The fracturing did not extend to the Silurian strata which, being previously undisturbed, underwent simple folding.

They subsequently offered, therefore, no suitable channels for the circulation of the solutions and did not become mineralized.

The fracturing of the older rocks was best developed in the harder beds, such as the Mytton grits, becoming ill-defined and dissipated in the soft shale bands. The former, therefore, by affording a free circulation to the ore solutions, favoured mineralization, whereas the latter, by offering difficulties of negotiation, retarded or opposed deposition. Hence the mineral contents of the fissures do not extend for indefinite distances, but are intimately related to the country rocks and may be definitely allocated to particular horizons.

The source of the ores may be traced to deep-seated igneous activity connected with the earth movements, and they probably originated with the intrusion of subterranean granite masses, which subsequent denudation has not yet exposed. The solutions emanating from these intrusions deposited, so far as the evidence goes, first ores of copper followed by those of zinc and lead, and finally barytes. The main zone of copper deposition was in the deep-seated Pre-Cambrian rocks, while the deposition of zinc and lead ores and barytes took place in the overlying Ordovician strata.

Faulting along the margin of the Pre-Cambrian mass, subsequently to vein formation, has brought the zinc-lead-barytes zone of the Ordovician alongside the copper zone of the Pre-Cambrian, much of which, together with the overlying rocks, has been removed by denudation.

The exposed occurrences of copper ore in the Pre-Cambrian rocks are the result of considerable alteration and rearrangement of material, and no primary deposit has yet been observed. This portion of the zone has evidently experienced considerable leaching, and enrichment may be expected in depth, but the observed data do not warrant the expectation of any large bodies of ore.

The barytes now occurring in the Pre-Cambrian rocks is a secondary deposition of material derived from the upper portions of the veins during the denudation of the overlying strata. It is, therefore, superficial in extent, and unlikely to persist beyond moderate depths. It is widely distributed in veins of a somewhat impersistent character, varying from mere stringers up to deposits may feet in width. Considerable quantities of the material should be available.

4—4

No ore formation took place in the Cambrian shales. In the succeeding Ordovician rocks deposition took place chiefly in the Mytton beds, where the solutions were apparently dammed back by the overlying Hope shales. Such solutions as penetrated beyond that horizon appear to have carried principally barium and only small amounts of lead. Considerable bodies of the former material have been encountered at higher horizons, but no commercial deposits of lead are to be anticipated.

The vertical range of the productive lead and zinc ground is thus between the base of the Hope shales above and the Stiperstones quartzite below, with a maximum depth, where the beds dip most steeply, of about 2,000 ft. The upper portion of this zone, down to about 1,200 ft., is principally lead-bearing, below which there is a predominance of zinc. Horizontally the distribution of the ore is influenced by the alternations of grit and shale, the shoots, or rich portions, occurring in the former and dipping westward with the strata. The richest bunches of ore occur in pipes along the junctions of the two sets of fissures where these cross one another, as at Tankerville and the Bog Mines.

The barytes belongs to the last stage of mineralization; it therefore often forms a capping to the veins and gives place to lead in depth. The latter mineral, in its turn, becomes largely replaced by zinc, and it is likely that there will be a general impoverishment towards the bottom of the zone. The district undoubtedly still contains considerable reserves of zinc ore, but so far as lead ore is concerned several of the deposits appear to be worked out.

Acknowledgment.—Most of the information given in this article was obtained during an examination of the district made on behalf of the Shropshire Mines, Ltd., and the writer is indebted to the chairman and directors of that company for their courteous permission to make use of it.

Copper Exports from the United States during the twelve months ended June 30, 1922, amounted to 338,743 tons. Of this amount Germany took 129,165 tons; France, 56,400 tons; Japan, 44,350 tons; Great Britain, 19,467 tons; Belgium, 18,007 tons; Italy, 17,431 tons; Holland, 16,486 tons. The total exports during July, 1922, were 28,760 tons.

BORING FOR OIL WITH THE DIAMOND-DRILL

By FREDERIC C. GILL and J. A. MacVICAR

The Authors, in separate articles, discuss the application of the diamond-drill to oil prospecting and oil production.

ADAPTING THE DIAMOND-DRILL TO THE OILFIELD

By Frederic C. Gill

The utilization of the diamond-drill in oil development, both in wildcat territory and for production in known fields, is being watched with close attention. It has proved at once distinctly applicable to the work, and it is pregnant with economic possibilities. It has necessitated a few new appliances and the re-designing of some of the tools, owing to the increased diameter of the holes desired and the additional weight resulting therefrom. However, most of the tools that have found favour and have given satisfaction to the users of diamond-drills for some forty years in the exploration and development of coal and mineral lands and in engineering test work have proved similarly applicable to drilling oil wells for production.

A considerable number of deep diamond-drill holes had been drilled in various parts of the world, as well as a goodly number of holes in mineral districts of the United States to the same depth as producing wells in the average oilfield, that is to say, in the 2,000 ft. to 3,000 ft. horizon ; and it was decided that the same type of machine which bored these holes, with minor changes, would prove entirely satisfactory for oil-field work. This is the type of machine that has recently drilled several producing wells in the Panuco district in Mexico, and is the only type of diamond-drill at the time of writing in actual service in the oilfield of Mexico, several oil districts of the United States, and foreign countries, for production purposes. A close liaison has been maintained between purchasers of these drills and the manufacturers, and the few errors that developed, or changes in equipment that became desirable in actual practice, have been taken care of, so that the machine now supplied can be said to have reached as perfect a development as have the other oil-field rigs, the standard and the rotary ; and they will not need the lengthy period of experimentation and improvement that the rotary had.

As in the smaller types of diamond-drills so well known in the mining districts, the single hydraulic cylinder is retained as a feed apparatus as being the best from an engineering viewpoint. As the rods, or drill stem, pass through the centre of the cylinder, the line of pressure is always directly in the line of the rods, and cross or side stresses are avoided and friction of working parts is at a minimum. The single hydraulic has supplanted all other feed methods on all modern diamond-drills with the exception of very small machines.

Two methods of piping the hydraulic for the feed valves are being tried out, and, as both have their admirers, a choice will probably be the rule for some time to come. One method is the usual four globe valves, and the other consists of a four-way valve and one globe. Where the work is to follow generally the rotary system of drilling, it is very probable that a little time is saved with the four-way ; but it is a minor change and the experienced operator finds little to choose between them and handles each with the greatest facility.

The single hydraulic meets with the instant approval of all practical rotary drillers, tool pushers, and officials of oil companies who have watched its perfect control of the drill stem and bit. The constant, even feed, variable to suit the hardness or softness of the formations being penetrated, the powerful lift independent of the turning, so desirable in "gumbo" and shales that ball up the fishtail and prevent fast and free circulation of the mud fluid, are pronounced ideal.

The engine and hoisting drum, with the necessary gearing, remain the same as in those machines that have been used on the deep diamond-drill holes all over the world, with the exception of some bearings, which have been enlarged. A single travelling sheave has up to the present handled all lines of casing. A multiple sheave can also be used, but it has not been necessary for the work so far completed by the diamond drill, although it will be required where long lines of heavy casing must be handled.

The derricks in use are of both tubular and structural steel types, respectively 67 ft. and 64 ft. in height. Both styles are meeting with favour, offering quick erection, and low primary cost, with a long life if kept painted. One derrick has brought-in

three wells, and is now being erected on the fourth with no apparent deterioration. There is some discussion about the height, and the near future will probably see 80 ft. steel derricks being used experimentally by diamond-drills on deep work, pulling rods in 60 ft. stands instead of 50 ft. as at present. Sheaves, both hanging and travelling, have been made of much heavier construction than formerly, and have a high factor of safety. Connexions between the travelling sheave and the hoisting and water swivels are made with "C" links and "U" clevises. A one-inch cable has been found to be the correct size with the single travelling sheave.

The ball-bearing hoisting swivel and the safety clamp—the latter an automatic "spider"—are much the same as in the smaller drill outfits, but have been increased in size to meet the requirements of drilling larger holes with larger drill rods. For handling various sizes of casings, a small-sized standard spider is used with the necessary slips for the sizes of casing being inserted. A ball-bearing water swivel has been designed along the lines of the rotary water swivel, but of lighter construction.

To bring-in a gusher of stupendous production has always been a problem for oil men, entailing much personal as well as financial risk; and, while many schemes are tried, it is an altogether too frequent news item that a big oil well is running wild after blowing the tools out of the hole, damaging the valve so it could not be closed, etc. In applying the diamond drill to oil prospecting and production, the problem of bringing-in a well under great pressure has been given much consideration. Conversant with all the dangers of drilling-in with the rotary and standard rigs, in the main oil men have been dubious of the diamond-drill with its small drill stem of light-weight material. However, after seeing how the drill rod is held firmly in the jawed chuck, they have readily admitted that it would be impossible for a gusher or sudden inflow of high-pressure gas to throw the rods out while drilling, and that the well could be brought-in with no danger to the crew, and the drilling continued below the strike if desired.

The problem in bringing-in a well under high pressure is to get the tools out safely and close-in the well until it can be connected to the line conducting the oil to storage. At the moment of the bringing-in, the diamond-drill tools are absolutely safe, and there can be no danger unless the chuck holding the rods is released. A system of extracting the rods under restraint has been worked out involving the use of two small sheaves, one fastened to the floor at one side of the safety clamp, and one connected upright to the top of the line of drill rods. The end of the hoisting cable is fastened to the timber supporting the drill frame opposite to the small floor sheave, and passes over the sheave connected to the top of the rods, down around the sheave at the floor, up over the sheave at the crown block, and down to the drum of the drill. This makes the withdrawing of the rods under absolute command of the driller, as it is handled with his hoisting drum brake, and the upward rate is always under very powerful control. Snubbing out with a manila rope was first used, but the strain was all on one side, and it was found the drill rods bent badly. The present arrangement eliminates this and works admirably.

In some fields the flow of wells is often by "heads," the pressure rising quickly and then dropping, in successive waves. This necessitates holding the rods after they have been raised from the bottom of the hole to keep them from dropping back when the pressure becomes insufficient to sustain the weight, and retaining at the same time the appliance to prevent the gas or oil pressure from blowing the line of rods out of the hole. It was deemed best to try a small auxiliary hoist for this purpose, to handle the snubbing control when the load was heavy, and the lifting when the greater part of the rods had been pulled out and it became necessary to oppose the pressure acting against the reduced weight. This effectively handles the problem, although it has not been tried out on a large well to date.

Another appliance has been designed to resist the pressure tending to throw the rods out and to act as a drag when withdrawing the line of tools. It has been dubbed a "rod brake." It is attached to the casing valve by a nipple, and is thus below the derrick floor. A lever, actuated by a screw arrangement operated from the floor by the driller, forces toothless jaws of special construction and design against the rods, the resultant friction counteracting much of the pressure of the oil or gas. The tension of the jaws against the rods can be varied to suit requirements and pressures. With the small-size drill rods used by the diamond-drill for obvious reasons, the weight

should not be allowed to rest on bottom and especially so when the diamond bit is being used. The rod brake is very handy to hold this weight when releasing the chuck to permit raising the hydraulic. So applied it becomes a safeguard should the well come-in suddenly when the chuck is not securely tightened on the rods.

Various sizes of stuffing-boxes are provided to fit the different sizes of tools that go into the hole. These screw on the rod brake and effectively prevent a messy floor when the well comes-in. They are of single and compound design, so that one size or a number of different sizes are taken care of.

While no big well has to date been brought-in by the diamond-drill, it is very probable one will in the near future. It is believed that all contingencies are provided for, and that the well can be handled with more security than with standard tools, while the possibilities of losing control are so reduced as to be negligible. With many machines taking the field, competent personnel is being developed rapidly, and we may look for a further reduction in drilling costs as these men become more familiar with oilfield procedure in the different sections of the world where the diamond-drills assume the leadership, and the future will probably see it utilized as the only machine for this purpose.

ADVANTAGES OF THE DIAMOND-DRILL IN THE OILFIELD

By J. A. MacVicar

Until very recently all wildcat and development drilling in the oilfields of the world has been conducted by means of either the standard cable drilling rig or the rotary drill, and at times with a combination of both. In favourable formation and to depths of from 700 to 1,000 ft. the standard rig is by far the most efficient ; to greater depths its efficiency is impaired by the greater weight of equipment and the necessity of strengthening the machine for the much greater loads ; also when water stands in the hole its advance is retarded by friction on the line and the effect of the water in cushioning the drilling head, preventing its oscillation.

Where long lines of casing have to be carried through sand or soft sediments, the rotary drill is most efficient, being able, by utilizing a mud-laden fluid, to advance a string of casing of given size to depths impossible with the standard rig. But by this method there is always the danger of passing through oil sands and completely sealing them off without their presence being noted by the borers. In some instances in Texas, an examination of the cuttings revealed the fact that oil-bearing ground had been passed through without having been noticed in the bore.

The rotary drill loses its efficiency where the strata are of an alternating nature, that is, where the soft sediments are interspersed with very hard layers, and in cases of this kind it requires both the foregoing types of drill to complete the bore. A system that requires the expenditure of large sums in having to maintain two distinct outfits impelled oil engineers and geologists to look around for a more economical method of wildcatting in virgin territory, and this turned them naturally to the diamond-drill, as being the speediest, most mobile, and accurate instrument with which to gather geological data in new regions. In its initial work in oil drilling the results were striking. It was found that the diamond-drill really accomplished results that heretofore had required the combined use of both cable and rotary systems. It is highly efficient in using the mud-laden fluid, and not retarded by the harder strata ; in fact, it was found that strata which were hard for the cable drilling rig, and too hard for the rotary drill, were rather easy to the diamond-drill, but the greatest advantage lay in the extraction of a core.

Respecting these cores extracted by the Sullivan drill from one of the first holes put down by this method in the Tampico district of Mexico, a geologist of the United States Bureau of Mines wrote : " Probably no one feature of the drilling attracted as much attention as the cores. It was a new and satisfactory experiment to both operators and geologists to be able to see and handle the rocks which were actually producing the oil. Sometimes the gas could be seen bubbling out of the core. Many of the cores contained fractures, which, when broken open, were found to contain drops of oil, until at about 1,850 ft. they began to give actual production. The well came in rather gradually from that point, until at 2,153 ft. enough oil was struck to bring the production up to 1,200 barrels. It was observed that these fractures occurred in zones. The drill would penetrate 20 or 30 ft. of fractured ground and then go back into solid rock again. This would continue for 50 or 60 ft.

and then another fractured zone would be encountered. This information would have been very important had it been desirable to shoot the well. The shooter would have known, almost to the inch, just where to put the shot, and he could have judged much more accurately as to the amount of explosive required. In general, it is hard to over-estimate the practical value of the information to be obtained from such cores. The ordinary practical oil operator can obtain more information from them than the trained geologist does now from a microscopic study of the well cuttings."

This core-extracting feature of the diamond-drill precludes the possibility of passing unnoticed through oil-bearing strata while using the mud-laden fluid. In wild-catting in new territory the diamond-drill cores from a single hole will probably give sufficient evidence to warrant extensive drilling for production or demonstrate that no further expense is justified. If the oil sands are not present, the cores will prove this fact positively.

The speed of advance attained by the diamond-drilling process is greater than that of others for several reasons. The holes drilled in most cases being smaller, it is possible to attain greater depths with line pipe of a given size, so that it is seldom necessary to resort to offsetting. The diamond crown cuts hard formation faster than either the solid head of the standard rig or the toothed crown of the rotary drill, and in soft strata its speed is at least equal to that of the rotary.

The diamond-drill also has the advantage over other types in that it is a much lighter and more portable machine and outfit in every respect, which is a very important consideration in attacking new territory, and especially so where the new territory is in remote regions and difficult of access. A standard cable drilling rig, equipped for a depth of 3,000 ft., will weigh 125 tons. Where it is necessary owing to alternating formation to use a combination of both standard and rotary, the outfit and equipment will weigh 250 tons. A diamond-drilling outfit capable of doing the work of both the standard and rotary combined, to a depth of 3,000 ft., will weigh under 40 tons, with the added advantage of being capable of mule transport, as it can be knocked down into pieces suitable for such.

When wells are to be drilled by the diamond-drill for production purposes, a 3 in., or 4 in., oil string is used, with larger casing to cut off water or caving material. There is a mistaken idea that the production of a well is governed by the size of pipe. This is true to some extent on offset wells where it is desired to get the maximum flush production, but otherwise a small casing will give the same results without the danger of drawing in sand or water. Gas pressures are maintained for a longer period, and net results over a given time will be about the same. There is no advantage in using casing larger than the flow line in a flowing well, and there is no advantage in setting casing larger than is necessary to take care of the pump in a pumping well. It is of interest to quote details of a well which is flowing 1,200 barrels per day through a 4 in. casing. This well was drilled by a Sullivan diamond-drill in one of the lean parts of Tampico, Mexico. It is known as Panuco-Boston Ugarte well No. 6. Average cutting with a 4 in. fish-tail bit was 10 to 18 ft. per hour. At a depth of 1,407 ft. the 4 in. casing was cemented into the limestone and a $3\frac{5}{8}$ in. diamond crown was attached to a 13 ft. core barrel, removing a 3 in. core. An average speed of 75 ft. per day was maintained down to 1,850 ft., and from that point down to 2,153 ft., where the hole was stopped, 35 to 40 ft. per day was made. This reduction in speed was caused by running into the full oil pressure of 480 lb. per sq. in. The total time occupied on this hole, including delays for which the drill was not responsible, was less than three months, as compared with an average time of five months for the district. As has been said, this well with a 4 in. casing flows 1,200 barrels per day, while not far away another well, drilled by a standard rig, is producing 500 barrels per day through an 8 in. casing, which is contrary to the ordinary expectation that the larger casing should give greater production.

The ability of the diamond-drill to bore a small hole is an important advantage in wildcatting. It should be remembered that the efficiency of the standard cable drilling rig depends on its being able to work with tools of large diameter in order to secure the necessary weight for cutting speed and enable larger casing to be set when water or caving ground is met with, without unduly reducing the diameter of the cutting head. There is no mechanical reason why the diamond-drill cannot drill large holes, but a 2 in. core from a 3 in. hole will give as much information on geological conditions as a large hole ;

and will give far more information than the non-coring type, regardless of size of hole. The diamond-drill can bore to great depths, extracting a core all the way. One instance may be taken in which the Sullivan drill bored a hole to 6,340 ft. in fourteen months, coring all the ground passed.

The advantages of the diamond-drill as an instrument in oil drilling may be summed up thus :—

By the removal of a core accurate records of underground conditions are furnished.

It is more rapid than either the standard or rotary drills.

It is practically two drills in one in that it operates equally well in soft or hard strata, and employs mud fluid if necessary.

It is adapted to structure testing, wild-catting, and production drilling, at any size, to any depth, within the limits mentioned.

THE RUSSIAN PLATINUM INDUSTRY

A Statement as to its Present Position

By ERNEST W. LEIGHTON, M.Inst.M.M.

From whatever standpoint an attempt is made to review the existing position of platinum and its possible future, one is faced with the fact that for a long time past business in that metal has been upon a very reduced scale comparatively with that which formerly obtained, and in the presence of such a fact the question immediately arises as to what is going to happen in Russia, the natural home of platinum.

The reason for such a question is not far to seek, not only because of the above conditions, but on account of the dominating part which that great country has played ever since there has been a platinum industry, and also because of the probability that before very long it will again be possible for its virtual world-monopoly of production to be resumed.

It is a striking commentary upon the destruction wrought in this, as in other industries, under Soviet influences that the centenary of the first authentic records of platinum production in Russia witnessed an output of new mineral probably inferior to that of the first year's working! But during that century very great things were accomplished, and the record of the contribution to the world's treasure and to industrial progress remains as an inspiration to those who now only await a fair opportunity to re-create the industry.

To give in close detail any data of the Russian production of platinum mineral or its sources in the various districts of the Ural Mountains would occupy too much space, but a rough outline of such details will enable the reader to form some sort of judgment for himself as to potentialities.

Found on both the eastern and the western slopes of the Urals, and comprising both "dark" and "silvery" mineral (the latter being the richer both in platinum and iridium), the output may be roughly divided into two parts, one being that which is produced by the larger owners such as Demidoff and Schouvaloff, working largely in normal times by means of dredges, while the other comprises the smaller producers, operating in comparatively primitive fashion, yet having an aggregate output not much inferior to that of the larger properties, and being able to resume operations and produce mineral much more speedily than will be possible on the great estates.

The following figures of output indicate notable totals, the Russian pood being equivalent to 526½ ounces troy, while the average content of pure platinum may be taken at fully 80% of such total.

Year.	Poods.	Year.	Poods.
1900	310	1908	298
1901	388	1909	313
1902	374	1910	335
1903	366	1911	352
1904	306	1912	337
1905	320	1913	299
1906	352	1914	298
1907	328		

Such "official" figures as are available in regard both to output and export are all vitiated to a greater or lesser extent (and competent opinion upon the point varies) by the quantities that paid no tax and illicitly left the country.

From various reasons, among which the impoverishment of certain deposits was contributory, the output was on a diminishing scale even before the commencement of the

Great War, but it was the Revolution and the dispersion of the "brains" of the industry that brought about the virtual cessation of serious operations, which has continued until the present time.

Had there been no opportunity during the years which the locusts have eaten in Russia of minimizing the disaster there, the effect upon the value of platinum (which in spite of all that has been done is ineffectively replaceable by substitutes) would have been much greater than proved to be the case. But the Choco District of the Republic of Colombia, certain nickel-copper mines of the Sudbury district of Ontario, and the American electrolytic copper refineries all contributed their useful shares of "new" platinum to tide over the interval and the demands for warlike purposes. The first-named production from these auxiliary sources is largely American-controlled, and very little of it finds its way to this side of the world; moreover, any heavy fall in value would probably be speedily reflected in a diminished output. The other sources, while well able to withstand any such contingency in regard to price, are, relatively considered, not great in their yield.

Our survey, therefore, of the potentialities of this industry in the future heads back to Russia, the predominant partner in output under almost any circumstances short of the "dead hand" of Bolshevik control. Space forbids more than a slight reference to what has happened during the past eight years in respect of the disappearance of various personalities, the breaking up of the international selling organization, the expiration of old long-period contracts, and the emergence of new factors, fresh producers and personalities.

For a great number of years previous to the general upheaval it had been maintained by many Russian producers, and especially by those who took a direct personal interest in the matter, that the crude mineral ought not to be merely exported, as was a regular procedure in the case of the larger owners, or sold on the spot to the buyers for foreign refining houses and dealers, as was the case with the smaller owners, but that steps should be taken to refine such mineral in situ, and thus to secure (1) control of the resultant pure platinum in the form of "sponge" or ingot, and (2) possession of the residual products from such refining, these containing the rarer metals of the platinum group, namely, osmium and iridium in comparatively considerable quantity, rhodium and ruthenium in lesser quantity, and a small complementary output of palladium.

To implement this contention might be considered the *raison d'être* of the Association of the Gold and Platinum Producers of Russia founded by Mr. Philip A. Ivanoff, who in spite of the calls upon his time and activities arising from the high offices he was called upon to fill, never lost sight of this quite sound demand from a Russian point of view. Himself a mine owner and producer, he knows the position *à fond*, and in 1913 had the gratification of seeing his views given legal effect by the passing of an Act imposing an export duty of 30% upon such crude mineral as might be exported. The practical effect of such an Act (which came into force on August 22, 1915) was naturally to make such exportation an economic impossibility and to bring about the erection of a refinery in the Urals.

The functioning of such a refinery and the full application of the Act, with its provisions for an improved registration of mineral produced (which in itself meant much) were, however, projected into times that had already become troublous and uncertain, so that this brief outline of a matter of first-class importance to the Russian platinum industry can only conclude with the statement that the idea underlying the law still persists and will be persisted in by the Russians to the end that refining in the Urals is intended to be a prime factor in the future position, however much endeavours may be made to shape it otherwise.

The co-operative spirit that permeates Russian thought will unquestionably inspire all the reconstructive work that must be undertaken in the Urals. Already during many months past much patient thought has been given to this problem, and has now found tangible expression in the recent registration, under English law, of the Anglo-Ural Platinum Trust Company, Ltd., of which particulars are given overleaf, the nucleus of a much greater organization, free from the trammels of precedents, which will be evolved as time and circumstances dictate.

It is natural that Mr. Ivanoff, as chairman of the aforementioned Association, whose members will be the first to resume production, as well as by his long experience with platinum in Russia, should be the moving spirit among his compatriots, while for the practical development of the English

side of his ideas he has secured the co-operation of others well versed in the intricacies of dealing with this metal.

ANGLO-URAL PLATINUM TRUST CO., LTD.

SIGNATORIES.	PREFERENCE.	ORDINARY.
Richard C. Griffith, London, Assayer and Metallurgist.	500	2,000
Philip Ivanoff, London, Mining Engineer	500	2,000
Ernest W. Leighton, London, Metallurgist	500	2,000
Walter J. J. Franks, London, Assayer and Metallurgist.	500	1,000
T. H. Evans, Faversham, Director of Public Companies	500	1,000
S. Feodossief, London, Mining Engineer	500	1,000
T. Wallace Evans, Faversham, Secretary of Public Companies	250	
Leslie Urquhart, London, Mining Engineer		1,000
J. H. Wall, Frome, Company Manager	150	
K. D. Koliasnikoff, London, Mining and Metallurgical Engineer ..	500	1,000
E. Dalton Parsons, London, Merchant....................	1,000	1,000
H. G. Simmonds, London, Consulting Engineer	100	

Nominal capital £10,750, divided into 10,000 participating preference shares of £1 each, and 15,000 ordinary shares of 1s. each. Company registered July 4, 1922.

This organization will introduce into the Russian platinum industry the quite novel feature of co-operation between the producer and the consumer, thereby eliminating the speculative middleman, that *bête noire* of the Russian producer.

To what extent this Russian mistrust was justified may be a matter of opinion, but the following list of prices per ounce troy for platinum manufactured into simple forms at the close of each of the years already quoted is interesting and suggestive.

Year.	s.	d.	Year.	s.	d.
1900	79	0	1908	100	0
1901	80	0	1909	120	0
1902	80	0	1910	160	0
1903	80	0	1911	185	0
1904	81	6	1912	185	0
1905	88	6	1913	185	0
1906	150	0	1914 until		
1907	110	0	August	185	0

Between August, 1914, and the end of 1915 prices fluctuated within wide margins, being dictated by the circumstances of the moment, and in January, 1916, Government control was established with the price at 190s. per ounce. By December of that year it had reached 290s., and so continued until February, 1918, when it was raised to 400s., and was held there until January, 1919, when it was further raised to 442s.

During the latter months of 1919, and up to about April, 1920, some not very intelligent manipulation raised the figure to the quite unprecedented height of £40 per ounce, and even more, which was followed, however, by a continuous retrogression to a figure which left the inevitable aftermath of soreness in the trade against such unjustifiable and forcing tactics.

An attempt in January of the present year to repeat the manœuvre on a smaller scale only proved that with the loss of control of supplies the power to take such action had passed, and since then the price has remained upon that steady basis which alone is productive of sound business in all its aspects.

The determination therefore of the Russian producers to place themselves in a position from which they can control events in a much greater measure than has heretofore been possible is easily understood, and the constructive work in this direction—which must also include provision for preventing the unregulated return of platinum mineral to the open market—will be watched with interest and goodwill towards those who have been so sorely tried.

Lectures on Petroleum. — The lecture course on petroleum technology at the Sir John Cass Technical Institute during the autumn term comprises the following :—

October 9 : The Origin of Petroleum ; conditions favourable to its accumulation. By T. Dewhurst.

October 16 : Typical Oil Field conditions illustrated from well-known fields. By W. R. A. Weatherhead.

October 23, 30, and November 6 : Outlines of Oil Well Technology ; drilling systems, oil production, surface plant. By A. Frank Dabell.

November 13, 20, and 27 : Outlines of Refinery Technology ; definitions and signification of terms used ; general composition of crude oils, and considerations governing their refining ; general description of typical refinery methods. By J. McConnell Sanders.

December 4 : Application of Petroleum Products as Fuels. By Professor J. S. S. Brame.

December 11 : Application of Petroleum Products ; illumination, lubrication, etc. By Dr. A. E. Dunstan.

During Lent term there will be lectures on Natural Gas and Oil Shale.

BOOK REVIEWS

Thawing Frozen Gravels. By CHARLES JANIN. Technical Paper No. 309. Published by the United States Bureau of Mines.

Information regarding the use of water at natural temperatures in the thawing of frozen gravel in placer mining operations is given by Charles Janin in Technical Paper 309, just published by the United States Bureau of Mines. Experiments in cold-water thawing demonstrate that under favourable conditions the process is an assured success. It is proving of great value to the gold-mining industry of Alaska and the Yukon Territory, and is encouraging investigation and exploitation of areas of frozen gravel that had been considered of too low a grade for profitable mining.

In placer mining in the far north, one of the greatest difficulties encountered is the permanently frozen condition of the ground. In the early days of mining the ground was thawed by the primitive method of building wood fires on the surface, at the bottom of a shaft, or at the face of a drift. Although this method was slow and costly, a more effective one was not discovered until about 1898, when it was noticed that the steam escaping from the exhaust of a hoisting engine had thawed a hole in the solid "muck." Further experiments followed, and the direct application of steam through points proved so effective that it became the chief method adopted in thawing many millions of cubic yards of gravel for drift mining, surface mining, and dredging operations. Tests with hot-water thawing were made at different times. Experiments indicated that ground could be thawed by this method, but in comparison with steam thawing the latter was generally found more effective. At all events, no extensive thawing with hot water was ever done.

Thawing with steam points proved slow and costly under the most efficient management, its cost amounting in general to about 40% of the total cost of mining, and at some mines to perhaps 70 to 80%. The high cost of thawing required that the gravel mined should contain a much higher gold content than ground that could be profitably mined where thawing was unnecessary, and prevented the working of the lower-grade ground in the frozen areas.

About 1915 to 1917, different persons started experiments on an entirely new plan for thawing the frozen gravel. Water at the natural summer temperature was applied by drilling holes through the frozen "muck" and gravel to bedrock and the water was allowed to find its way through the gravel back to the surface. This water was taken from surface ditches, or through pipes under pressure, or pressure was obtained by pumping. The results of these tests were very satisfactory. Although there is still much to be learned regarding practical application of the method, thawing with cold water has passed the experimental stage and is being proved of great value to the gold-mining industry. The successful application of the method where water is obtainable under pressure without pumping will make large areas of so-called low-grade ground available for dredging, and ground that has previously been considered to be of little or no value will now be of economic importance. Had the knowledge of this method of thawing been available to the Yukon Gold Co. and other companies operating dredges in the far north during the past ten years, there might have been a considerable saving in costs and a correspondingly additional profit to those companies. A résumé of experiments in cold water thawing conducted in Alaska is given by Mr. Janin.

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(1) **Text-Book of Mineralogy.** By E. S. DANA. Third Edition, revised by W. E. FORD. Cloth, octavo, 720 pages, illustrated. Price 25s. net. New York: John Wiley & Sons; London: Chapman and Hall, Ltd.

(2) **General Economic Geology.** By WILLIAM HARVEY EMMONS. Cloth, octavo, 520 pages, illustrated. Price 20s. net. New York and London: The McGraw-Hill Book Co.

(1) Among mineralogical treatises, none are better known than those associated with the name of Dana; the "System" and "Manual" with that of James Dwight Dana, and the "Text-Book" with that of his son, Edward Salisbury Dana.

The "System" dates back to 1837, and between that year and 1868 was piloted by its writer through no fewer than five editions. The little "Manual" appeared in 1848, and during its author's life-time passed through four editions.

Immediately after the publication of the fifth edition of the "System," the elder Dana embarked upon a volume of intermediate size which was intended to meet

the requirements of class tuition. In this the principles and methods of mineralogy were to be more fully and the description of the mineral species less fully treated than in the "System." Unfortunately, the distinguished Yale professor's health early compelled him to relinquish this work, and he was not able subsequently to resume it. Under these circumstances he deputed his son, who in 1874 had been appointed a tutor at Yale and curator of the mineral collection, to edit the new volume on the lines he had laid down and with his co-operation, and from the hands of this young man of twenty-eight it eventually issued in 1877 as the well-known "Text-Book of Mineralogy."

During his father's life the younger Dana did not prepare any further edition of this work, but in 1892, after several years of arduous labour, he brought out the sixth edition of the "System of Mineralogy." In this task he was watched and encouraged by his father, who by this time was an old man, and who, indeed, at the age of 82, died three years after its publication.

Having brought his father's great work up to date, Professor E. S. Dana—he now occupied the chair of physics at Yale—turned again to the "Text-Book," and in 1898 produced that second edition with which the present generation of students is so familiar. As he tells us in his preface, the remarkable advances that had been made in mineralogy during the twenty-one years that had elapsed since the book was first issued made it necessary in preparing a new edition "to re-write the whole as well as to add much new matter and many new illustrations."

That was twenty-four years ago, and during the passage of this period similar if not greater progress has been made, with the result that further revision has gradually become necessary in order to bring the book abreast of the times. The author, now professor emeritus of physics, but still curator of mineralogy, and to-day in his 73rd year, has found in his young colleague, Dr. W. E. Ford, professor of mineralogy in the Sheffield Scientific School at Yale, an enthusiastic worker, both willing and able to carry out the responsible work of revision. It will be remembered that Dr. Ford has already prepared the second (1909) and third (1915) appendices to the sixth edition of the "System," and also a new edition (1912) of the "Manual." As the result of his latest labours he has recently produced the third edition of the "Text-Book," which is the subject of this review.

The changes to be noted in this new volume, though to a slight extent those of reconstruction, are in the main those of addition. No important modification has been made in the form of the book or in the mode of treatment. The subject matter still falls into two principal parts, an earlier, dealing with systematic mineralogy, in which the morphological, physical, and chemical aspects of minerals are discussed, and a later, dealing with descriptive mineralogy, in which the special characteristics of individual minerals are considered in detail.

The extent to which new matter has been added may be gauged from the fact that the volume now runs to 720 pages, with 1,050 illustrations, as against 593 pages, with 1,008 illustrations, in the previous addition.

The greater part of the new material is to be found in the systematic part of the work. In the section devoted to crystallography, which now constitutes an excellent epitome of that subject, reference is made to the modern study of crystals by means of X-rays, and to the light thrown by such researches as those of Laue and the two Braggs upon crystal structure. A useful description is also given of the principles and practice of crystal representation by the methods of stereographic and gnomonic projection. The account of crystal measurement and goniometry has also been slightly expanded.

Very important changes have been made under physical mineralogy, especially in the pages which deal with the optical characters of minerals. Great care has been taken in the presentation of this subject, a clear comprehension of which is now so necessary to the student. The underlying principles, as also the application of them to the determination of the optical diagnostics of minerals with the microscope and other instruments, are explained and described with admirable lucidity. In this part of his work Professor Ford has been conspicuously successful, and many a student of mineralogy and petrology will have reason to be grateful to him for the trouble he has taken to attain clarity in this difficult subject without sacrificing fullness of information. This hundred pages or so constitutes perhaps the best brief statement of this branch of mineralogical technique that is available to the student in the English language.

The short section, of about 40 pages,

dealing with chemical mineralogy, has been but little modified. The list of elements has been brought up to date, a new table of the periodic system replaces the old one, and paragraphs have been added on the variation in chemical composition of minerals, and on mineral gels. Otherwise, these pages stand as they were.

In that part of the volume which deals with descriptive mineralogy no substantial alteration has been made in the scheme of classification, which, as before, is based primarily upon chemical composition and secondarily upon isomorphous relationships. This classification is on the whole satisfactory, since it rarely brings about associations which are manifestly arbitrary, and, with few exceptions, causes minerals which have essential similarities to come together into groups which we feel to be natural.

The principal change in this section is the inclusion of a large number of minerals which are not described in the edition of 1898. Most of these had not been recorded twenty-five years ago, while a few, though already known, have only in the interval become of sufficient interest or importance to demand consideration in a book of this scope. Benitoite, betafite, carnotite, hulsite, patronite, stibiotantalite, stokesite, temiskamite, and thorianite, are a few of these minerals which, though well known to-day, and dealt with in the new edition, are absent from the earlier edition.

The number of mineral names now appearing in the index for the first time is close upon four hundred, evidence not only of the growth in our knowledge of the mineral world that has characterized the last quarter of a century, but also of the necessity for frequently revising our works of reference. The inclusion of these additional species has caused an increase of some thirty pages in this section.

The volume, as before, closes with two appendices. Both of these have been considerably improved. Appendix B, on the drawing of crystals in orthographic and clinographic projection, gives such clear instructions as to the mode of procedure for the several systems that, given the necessary data as to axial elements and form symbols, a careful student should have no difficulty in making accurate drawings, in the conventional positions adopted by crystallographers, of any crystals that may come into his hands. Few students realize how relatively easy such drawings are to make or how fascinating such work is. Further, exercises of this kind are of the greatest value in driving home the facts and principles of crystallography.

In Appendix B the tables for the determination of minerals have been enlarged so as to include the species new to the volume, and a fresh table showing all the described minerals classified according to their dominant bases and acid radicals has been added. With use, these tables should prove of very real service in the practical work of mineral identification.

Most of the new figures in the book, of which there are a large number, are well drawn and effective. It is a pity that the frontispiece of former editions, showing the principle types of interference figures in colour, has been omitted.

In his preface Professor Ford says that "throughout the book the endeavour has been to present in a clear and concise way all the information needed by the elementary and advanced student of the science." This endeavour has been entirely successful, and the book in its revised form will prove indispensable not only to students but also to experienced mineralogists.

(2) Professor Emmons in former publications, for example, "The Enrichment of Ore Deposits" (1917), "The Principles of Economic Geology" (1918), and "The Geology of Petroleum" (1921), has confined himself to certain aspects or sections of economic geology. In his latest book, which "embraces the geology of mineral fuels, structural materials and other non-metals, and of the metals," he covers the whole range of the subject. But notwithstanding the comprehensiveness of its contents the volume is of only moderate size. Indeed, with its 516 pages it is smaller than either of the foregoing works, which contain 530, 606, and 610 pages severally. Consequently, in his treatment of individual subjects the author has necessarily had to be brief, sometimes very brief. In this connexion it should be pointed out that the volume, although containing a remarkable body of valuable instruction, is intended only as "an introduction to the study of mineral deposits," and the writer, in making this clear in his preface, suggests that its perusal "might well be followed by specialized courses on coal and petroleum, and a more advanced course on the metals." With the object of enabling the student to acquire fuller information concerning any particular

subject in which he may be specially interested he gives copious references to relevant literature, which by providing selected supplementary reading add greatly to the usefulness of the book.

Perhaps the laudable attempt to compress the maximum of information into the minimum of space has been attended with a certain loss of that interest which is so desirable in introductory treatises, and with which the subject of mining geology, if spaciously presented, is so richly endowed. Possibly this may also be in part connected with the fact that the volume is largely built up of excerpts taken with little or no modification from the before-mentioned works, spontaneity and sequence having thus been somewhat impaired.

Of the twenty-one chapters into which the contents of the book are divided, five deal with general considerations affecting mineral deposits as a whole, and the remainder with specific materials. Of these latter four are devoted to fuels, seven to other non-metallic mineral substances, and five to the useful and precious metals.

The chapters on general matters relate to such questions as the geological processes by which mineral deposits originate, the mechanical deformation and chemical alteration by which their primary characteristics of form and composition are modified, the genesis of the fissures and other cavities by the filling of which mineral veins arise, and the formation of mineralized zones by rock replacement.

Under fuels two chapters are given to petroleum and related hydrocarbons, and two to coal. Those concerned with the former deal with the nature, properties, occurrence, and origin of petroleum and natural gas, and with the principal fields from which supplies of oil, oil-shale, and asphalt are obtained. Of the chapters on coal the first touches upon such matters as the constitution and structural features of coal measures, the alteration of coal seams by metamorphism and weathering, and the sampling and analysis of coals ; the second gives a brief description of the chief coalfields of North America.

The hundred pages or so devoted to the non-metallic minerals other than coal treat of a somewhat heterogeneous group of geological materials. These range from the rocks drawn upon for constructional purposes and for the manufacture of ceramics and refractories, to economic rock-forming minerals like felspar, mica, quartz, etc., gems, magnesian minerals such as asbestos, talc, and magnesite, phosphates, the useful salts of the saline residues, and miscellaneous minerals used in the industries as abrasives, pigments, fillers, and so forth. The lengths to which the author has been impelled by the desire for inclusiveness and the need for condensation are exemplified by the relegation of water to the category of miscellaneous minerals and the treatment of its economic aspects in the space of three pages.

In the concluding chapters the geology, distribution, and resources of the metals are considered. One chapter is assigned to iron, one to copper, one each to gold and silver, and lead and zinc, respectively, and the last to the remaining metals. Here, again, the limitations of space are severely felt, the important metals aluminium and nickel being each disposed of in less than three pages, and tin in one. As already stated, however, the author has made the best amends possible for this unavoidable brevity of treatment by quoting in this and other parts of the volume a number of standard articles published elsewhere, from which, if it were required, a fuller knowledge might be obtained.

To those who ask for the large outstanding facts relating to economic geology, and who wish to find them between the covers of a small volume, this book will be most welcome.

C. G. CULLIS.

Platinum and Allied Metals (1913–1919). Pamphlet, 84 pages. Price 2s. net. Published by the Imperial Mineral Resources Bureau as part of the Mineral Industry of the British Empire and Foreign Countries.

This publication is divided into six chapters, namely : General, Prices, World's Production, British Empire, Foreign Countries, and References to Technical Literature. It is concise, and contains extremely useful information, compiled with great care. This remark applies equally to the text and to the many tabulated statements referring to prices, production, imports, exports, and many others. The publication is not quite free from misspellings, evidently printers' errors, such as the following : page 51, 6th line from top, read " basin " for basis ; 11th line from top, Veresovy " Bor " and Svietly " Bor " instead of Bar ; on page 53, 28th line from top, " Kia " instead of Kiu. These are of minor importance, but should be corrected when

being incorporated in the larger volume of which this publication is a part. The references to technical literature are extensive, 154 publications being mentioned. The publication undoubtedly contains up-to-date information, valuable to those interested in platinum and allied metals.

A. L. SIMON.

LETTERS TO THE EDITOR

Leaching Whim Well Copper Ores

The Editor:

SIR — In the notes I wrote you on March 14, and published in the July issue, dealing with the contemplated method of leaching the ores of the Whim Well and Mons Cupri mines, I alluded to the use of pyrite both for destroying ferric sulphate in the liquors before cementation and for creating solvent for leaching the ore. I stated that the use of pyrite for the former purpose had been patented by Mr. Joseph Irving, of Bisbee, Arizona, and that I believed the idea of using pyrite for the latter purpose was new.

Mr. Irving writes me that he is using pyrite for that purpose, and that certain American patents of his cover this use of pyrite.

The idea of using pyrite as a creator of solvent for leaching oxidized copper ores suggested itself to me after reading an article mentioning pyrite filters as correctors of ferric sulphate, and long before I heard of such being used for other purposes. Further, I have carried out my own experimental work on it, and I have now no idea as to whether the method of manipulation used by Mr. Irving for this purpose is similar to the one I have in mind and on which I have been experimenting.

I have myself taken out Australian patents for the use of iron sulphide as a creator of solvent for oxidized copper ores. The iron sulphide will no doubt in practically all cases be pyrite. It appears, however, that Mr. Irving is the first to have utilized pyrite for the purpose of assisting in the leaching of copper ores. I believe, indeed, that he has been a pioneer in the adaptation of simple methods to copper leaching in late years, which have been of great benefit more particularly with respect to low-grade ores in Western Australia.

I infer from a late article by Mr. Irving in the *Engineering and Mining Journal-Press* that he uses pyrite to assist in leaching sulphide copper ore as well as mixed ore, and presumably also oxidized ore, mainly in the heap leaching of low-grade material.

My patent applies only to the leaching of oxidized ore.

H. R. SLEEMAN.

Whim Well, West Australia.

July 15.

Grimley's Prospector's Balance

The Editor:

SIR—In the issue of the MAGAZINE for October, 1921, you published a description of my prospector's balance intended for use in connection with alluvial tin concentrates. It will be remembered that this balance was designed so that if the concentrates resulting from the washing of $\frac{1}{4}$ cu. ft. of ground be placed on it the value in pounds per cubic yard can be read from the beam. I should like to give here the method of using the balance when a weighed sample of ground is taken.

If the weighed sample should have a volume of $\frac{1}{108}$ cu. yd. $(=\frac{1}{4}$ cu. ft.), no calculation would be needed, the value of the sample in lb. per cu. yd. being read directly from the beam, just the same as when a *measured* sample of $\frac{1}{4}$ cu. ft. is taken. In all other cases, it is necessary to correct the beam reading, according to whether the weighed sample is more or less than $\frac{1}{108}$ cu. yd. in inverse proportion.

If the weight of 1 cu. yd. be assumed to be 3,024 lb., the weight of $\frac{1}{108}$ cu. yd. is 28 lb.

Then if W. = weight of sample in lb.

B.R. = beam reading.*

V. = value of sample in lb. per cu. yd.

the formula is:

$$W. : 28 :: B.R. : V.;$$

or multiply the beam reading by 28 and divide by weight of sample.

Example. W. = 56, B.R. = 4.

$$\text{Then } V. = \frac{28 \times 4}{56} = \frac{1 \times 4}{2}$$

$$= 2 \text{ lb. per cu. yd.}$$

Since $56 = 2 \times 28$, the volume of the sample is $2 \times \frac{1}{108}$ cu. yd. or $\frac{1}{2}$ cu. ft.; and the beam reading being 4, it is obvious that the beam reading or value for $\frac{1}{4}$ cu. ft. would be half, that is 2 lb. per cu. yd.

If 3,024 lb. is considered excessive for the

* When the medium or largest weight is used, the beam reading must be doubled or trebled as with volumetric samples.

weight of 1 cu. yd., and it is preferred to take it at say 2,916 lb., then the beam reading must be multiplied by 27 instead of by 28.

To find the weight of the concentrates in grammes, all that is necessary is to multiply the beam reading by 4·2. Thus, if a small weight is at 4, the weight of the concentrates is $4 \times 4{\cdot}2 = 16{\cdot}8$ grammes.

If the medium weight is at 10 and a small weight at 3, the weight is :—

$$(10 \times 2 + 3) \times 4{\cdot}2 = (20 + 3) \times 4{\cdot}2 = 23 \times 4{\cdot}2 = 96{\cdot}6 \text{ grammes.}$$

PHILIP GRIMLEY.

London.
September 20.

Salaries of Young Engineers

The Editor :

SIR—I have read with interest the Editorial comments in the July issue on my letter of May 25. Before closing this subject may I trespass on your space to place before those interested the following points ?

The well-known and successful mining man referred to in your Editorial accepted a salary of £20 a month immediately after graduation, presumably fifteen or twenty years ago. Reckoning conservatively, this would be equivalent to £30 per month at the present date. Allowing £200 per annum for subsistence this leaves a balance of £160 per annum for savings. My sole claim on behalf of the young graduate is that he should be in a position to save this sum annually, and £30 per month represents, in my opinion, the minimum salary which should be paid to a graduate engineer in temperate, healthy climates. Accordingly, on figures, the gentleman referred to in your Editorial and myself are really in agreement, although on the phrasing of the paragraph it would not so appear.

Finally, I would be doing an injustice to the class for which I speak if I closed without a gentle protest recorded in all humility against the statements contained in paragraph 3 of your Editorial comments. After many talks on the subject with my fellow fourth-year students, I was convinced that as a class we novices fully realize our limitations. After my first year's work in the profession I am equally convinced that we are worth £30 a month on the day we graduate.

E. G. LAWFORD.

Pachuca, Mexico.
August 11.

NEWS LETTERS

BRISBANE

August 9.

YAMPI SOUND IRON ORE DEPOSITS.—In a description, given in the MAGAZINE for December, 1920, of the iron and steel works which the Queensland Government then proposed to establish at Bowen, one of this State's northern ports, reference was made, on p. 351, to an option which the Mines Department held for the purchase of a large and rich deposit of iron ore on Cockatoo Island, Yampi Sound, off the north-west coast of West Australia. A report by the Western Australian State Mining Engineer (Mr. A. Montgomery) on the Yampi Sound iron ore deposits had been published in the MAGAZINE for the previous October. The Queensland Government, after receiving a report from three experts whom they sent round to the west coast to examine the Cockatoo Island portion of these deposits, exercised the option of purchase, and paid £30,000 in debentures for the mining rights of Cockatoo Island, plus £3,000 previously paid for the option. The experts who had reported on the proposition for the Government were Mr. E. A. Cullen, Engineer for Harbours and Rivers in Queensland ; Mr. C. F. V. Jackson, State Mining Engineer ; and Mr. J. W. Brophy, who had shortly before been appointed general manager for the non-existent State iron and steel works. Until lately the substance of only a part of the report of these three gentlemen—that giving the facts relating to the nature and extent of the deposits as well as to the surrounding conditions—had been made public. But the full text of this document has lately been laid before Parliament, and it shows that only one (Mr. Brophy) of the three experts recommended the purchase. There was no question about the quality or quantity of the Cockatoo deposits, which if anything were shown to be even more satisfactory than appeared from Mr. Montgomery's report ; but Mr. Cullen, who is especially qualified to speak on the transport question, and Mr. Jackson, who is a careful and experienced officer, did not recommend the exercise of the option, mainly because they were of opinion that the risks of transport of the ore from, and the difficulties connected with labour likely to be met with at, such an isolated, desolate, and waterless island as Cockatoo, situated as it is within the tropics, make it extremely doubtful whether it would

be profitable to mine and convey the ore about 2,000 miles from Yampi Sound to Bowen, on the eastern coast of northern Australia. Both considered that it would probably be cheaper to obtain all the iron ore required for the proposed iron and steel works from the deposits in the Cloncurry district, Queensland, some 500 miles by rail from Bowen. With these conclusions Mr. Brophy did not agree, and he strongly recommended the buying of the Cockatoo deposits. They were purchased in 1920, but as the Government has up to the present been unable to procure the money for the proposed iron and steel works, they are still untouched, and the money spent upon them is of course unproductive. In the meantime Mr. Brophy, who was appointed for a term of five years, has been given a position in the Mines Department, to do part of the work hitherto performed by Mr. Jackson.

HAMPDEN-CLONCURRY COPPER MINES.—One of the Cloncurry copper mining and smelting companies—the Hampden-Cloncurry Copper Mines, Ltd.—has presented its half-yearly report, and in it made an announcement which shows that they have no intention to resume operations under anything like existing conditions. This announcement is that the pumps have been removed from the principal of the company's group of mines, and the water has been allowed to rise in the workings, with the risk of endangering them. The directors state that before there can be a resumption of operations there must not only be a material improvement in the copper market, but a reduction in costs—including wages, railway freight, and fuel—to the extent of £20 per ton of copper produced, as compared with those prevailing in 1920, when the smelters closed down because it was unprofitable to continue them in commission. When the Government granted a concession in railway charges amounting to £1,100 per week to enable the Mount Morgan Company to re-start operations without involving a reduction of wages of more than from 5 to 10%, it was argued that similar concessions should, in fairness, be offered to other mining companies that had been compelled to cease work from causes similar to those that had operated in the case of Mount Morgan. Since then the Government has granted a reduction of 75% in railway rates for the carriage of the ore of copper "gougers" (miners in a small way) from the Cloncurry district to port. No reduction, however, has been obtainable in favour of any of the three Cloncurry companies, and the prospect of these resuming operations seems to be as far off as ever.

MOUNT CUTHBERT.—The half-yearly report and balance-sheet of the Mount Cuthbert Co., just issued, show a loss for that period of £9,835. Neither smelting nor development work has been done at the company's Cloncurry copper properties for the half-year, and there seems little prospect of a resumption of work in the early future. The general manager says that several things—such as reduced railway and shipping freights, cheaper fuel, lower wages, and an improved market—are necessary before a restart can be considered ; and apart from a slight improvement already showing in copper prices, none of these things seems likely to come to pass for some time. A short while ago the company asked for, and obtained, the consent of holders to postpone payment of debentures falling due as well as of the payment of interest. The ore reserves of the Mount Cuthbert Co. are put down at 193,500 tons, estimated to contain 13,245 tons of copper.

HERBERTON.—On the far-northern Herberton field, which in normal times is the chief tin-producing centre of the State, operations for the past eighteen months have been much restricted by low market values, but what work has been done has resulted so satisfactorily in several mines that are developing very well, and in new discoveries favourably affecting the potentialities of old ones, that there should be a decidedly improved output from this district, as compared with past returns, if prices continue for a reasonable time to rise as they have risen during the past two or three weeks. Among the mines of the district that have shown excellent results of late are the Wild Irishman and the Gordon, near Irvinebank. A new find, called the William Morris, has also been doing very well, and is giving promise of even better results in the future.

KANGAROO HILLS.—The Sardine North tin mine, a few chains removed from the now famous Sardine, on the Kangaroo Hills field, is coming into prominence. A short time ago 2 ft. of good ore was showing in the bottom of the mine, verifying the expectation, held for some time past, that the formation would develop into a lode. This ore, at a depth of 98 ft., is assaying 26% of black tin ; while a trial crushing from a new lens of ore at 60 ft. has gone 18%. The Canary tin mine, in the same district, has

just had a crushing of 12 tons that yielded 4 tons 5 cwt. of black tin. Much activity prevails on this field, which, like the Herberton, gives great promise for the future.

GYMPIE.—The No. 4 North Phœnix, one of the few gold mines remaining operative on the Gympie field, has of late been giving quite sensational returns. Last month from a crushing of 120 tons there was obtained no less than 3,400 oz. of gold, worth about £3 10s. per oz.; while a day or two ago another excellent crushing was reported, 129 tons for 711 oz. After the former crushing the company owning the mine declared a dividend of 5s. per share. This makes a total distribution to date of £4 18s. 4d. per share on 37,000 shares paid up to only 7d. per share, which means that the shareholders have put into the mine only £1,079 and taken out £182,533. The mine, which is among the oldest on the field, has in the past given some very high returns, but the former of the two mentioned above eclipses them all. The rich ore which has just given such excellent results, however, was not extracted from the company's original lease, but from adjoining ground taken up a few years ago after it had been abandoned by another company that had unsuccessfully worked it for many years.

TORONTO

September 11.

PORCUPINE.—The gold-mining industry continues to show rapid expansion, the production of gold during August from the Northern Ontario mines according to preliminary estimates being approximately $1,840,000, mainly from the Porcupine area. A large number of new enterprises are being undertaken and the work of exploration is being actively prosecuted. Over forty diamond-drilling machines are in operation in the district, and some 500 ft. of drilling is being done every day. The most important recent development is the opening up on the 1,875 ft. level of the McIntyre of a rich deposit, 500 ft. in length and 12 ft. wide, averaging over $20 to the ton. The annual report of the McIntyre for the year ended June 30 shows a recovery of bullion to the value of $1,937,109 with operating costs of $1,072,545, the net profits being $552,746, as compared with $815,530 for the previous year. Some delays have occurred in connexion with the treatment of carbonaceous ores in the new milling unit, but it is expected that these difficulties will be shortly overcome and production largely increased. Ore reserves are estimated at 718,198 tons containing $7,452,647, as compared with 624,422 tons containing $6,392,394 a year ago.

The Dome Mines is handling an average of between 1,000 and 1,100 tons daily, producing approximately $12,000 daily. Ore-shoots in the lower workings show a marked increase in gold content, a large proportion of the ore carrying from $20 to $40 per ton.

The Hollinger Consolidated is working out plans for a largely increased production. The mill is at present treating an average of 4,300 tons of ore per day, but considerable changes in the equipment are being effected. After thoroughly testing all types of milling machinery the management has decided to substitute rod-mills for stamps. The company is preparing to proceed immediately with the construction of a power plant on the Abitibi River for the development of 20,000 h.p. at a cost of about $3,000,000 and surveyors are at work on the site.

The Davidson Porcupine has secured $900,000, which will enable work to be resumed. The ore in sight above the 600 ft. level is estimated at a value of $3,500,000. Operations on the Vipond Consolidated, where the shaft was being put down to the 1,000 ft. level, have been interfered with, owing to a heavy flow of water, which has confined work to the upper levels. A shaft is being put down on the Rochester, where diamond-drilling has indicated an ore-body at the depth of 95 ft. At the Porcupine Crown operations have been extended to the west side of the property, where a vein is being opened up on the 500 ft. level. Promising discoveries have been made on the surface at the Holtyrex, and a shaft will be put down to the 500 ft. level. The shaft on the Goldale has reached the 500 ft. level, and a station is being cut. A mill with a capacity of 100 tons per day is being installed on the Clifton Porcupine and is expected to begin operations early in October.

KIRKLAND LAKE.—This area is attracting much attention from capitalists and exploration and development are being undertaken on a considerably larger scale than ever before. The Continental Mines has taken over 27 claims, constituting an area 3 miles in length by $\frac{3}{5}$ mile in width, immediately east of the present producing area. The company is capitalized at $3,500,000 and has $1,000,000 in the treasury for development purposes. The Nipissing of Cobalt has also entered the field and will begin the explora-

tion of its holdings in the same neighbourhood. The Lake Shore during July produced bullion to the value of $55,080 from the treatment of 2,098 tons of ore, being a recovery of $26·25 per ton. The enlargement of the mill has been definitely decided upon and preparatory work is in progress. The position of the Kirkland Lake Proprietary has been improved by a rich strike in the lower levels. The lateral development of the veins found on the surface of the Sylvanite has been started at the 500 ft. level, and cross-cuts will be driven across the entire width of the vein system. The shaft is also being deepened. At the King-Kirkland a station has been cut at 250 ft. and the shaft is down 50 ft. further. Good ore has been developed at the 100 ft. level. The Wright-Hargreaves is maintaining production at the rate of over $2,500 per day, drawing ore from all the levels so far opened up. The Goodfish has installed a new compressor and the plant is ready for operation. The shaft will be put down 300 ft. Work has been begun on the Dominion Kirkland south of the Canadian Kirkland.

COBALT.—The production of silver during August from the mines of Cobalt and the outlying districts amounted to approximately 850,000 oz. There were seven producing mines in operation. The McKinley-Darragh has struck a new vein of high-grade ore 3 ft. in width. The mill is treating ore at the rate of about 4,000 tons per month, operating costs being held down to about 35 cents for each ounce of silver produced. At the Genesee a rich vein has been encountered at the 500 ft. level, from which considerable high-grade ore has been extracted. The Continental Mines has acquired the Colonial property adjoining the O'Brien and will sink a shaft 800 ft., expecting to pick up the extension of the O'Brien vein at that depth.

SUDBURY.—The smelter of the International Nickel Co. at Copper Cliff was reopened on September 1, after having been closed down for 18 months, and is now operating at about one-third of its war-time capacity. The Creighton mine had resumed operation about a week before and a large quantity of ore was in readiness. Regular shipments of matte will be made to the refinery at Port Colborne, Ontario, where all refining will be done hereafter, the Bayonne, N.J., refinery having been scrapped.

ELBOW LAKE, MANITOBA.—The Nipissing of Cobalt has relinquished the option it held on the Gordon Murray property, after exploration by diamond-drilling. The Hollinger interests have also given up their option on their locations in that area, and these have been acquired by a company formed by Frederick G. Corning and Robert Sweeny, of New York, and W. R. F. Parker, vice-president of the Mining Corporation. Gordon Murray and associates retain a large interest, accepting shares of the company in payment of their claims.

VANCOUVER, B.C.

September 11.

CANADA COPPER.—The bond-holders of the Canada Copper Corporation are expected to foreclose at any time, and a committee representing the bond and stock holders has been formed, with a view either to the reorganization of the company or to the disposal of the company's assets. A party of engineers representing the Granby Consolidated made an examination of the property recently, and another party has made an examination in the interests of San Francisco capitalists. Including the 12-mile spur of the Kettle Valley railway from Princeton to Copper Mountain and the extension of the West Kootenay L. & P. Co.'s power-line to the properties, more than eight million dollars was expended in bringing the mine to the producing stage. Production was commenced in September, 1920, when the price of copper was low and the cost of labour exceedingly high, and after about a month's work, during which the concentrator was proved to give excellent satisfaction, the mine was closed and has remained closed since. Eleven million tons of ore running 1·75% copper with small gold and silver values is said to have been developed at Copper Mountain, and the 2,000-ton plant at Allenby, four miles from the mine, is probably quite the best equipped concentrator in the Province.

THE GRANBY CONSOLIDATED has made another sharp cut in the cost of copper production, and now is turning out blister at 9½ cents per pound. A further cut of about a cent per pound will be made when the new reservoir, now under construction, has been completed and ample power is available. This will bring the cost of production close to pre-war prices. Good progress is being made with the new dam, and the increased power should be available before the end of the year. A. Cole, of El Paso, Texas, is to superintend the construction of a 1,000-ton concentrator for

the Granby company. It will be remembered that the directors recommended this improvement in the last annual report. Granby engineers have examined a number of properties in the Omineca division.

THE BRITANNIA MINING & SMELTING COMPANY is making good progress with its new concentrator, and it is expected that it will be placed in operation early in the new year. It will have a capacity of 2,500 tons per day, and will be the biggest concentrating plant in the Province. The Britannia recently has made settlements to the amount of $56,000 to the families of miners who lost their lives in the flood of last October.

THE CONSOLIDATED MINING & SMELTING CO. has accumulated a large stock of lead bullion during the extensions that were made to its refinery, and, in order to get this out of the way and clear the decks for ore that is being received at the smelter, the company has arranged to have 4,000 tons of bullion refined at the Bunker Hill & Sullivan smelter, at Kellogg, Idaho. A "refining-in-transit" rate of $8 per ton to Portland, Oregon, is being made, and from Portland the lead will be shipped to Europe by way of the Panama Canal.

CARIBOO.—The shortage of water, caused by the unusually dry season, will prevent the washing of much ground that has been mined this summer, so it is likely that the output of the district will not approach earlier expectations. This is to be regretted, as it will defer the thorough testing of ground in some of the high benches until next year. Although the rush to the district did not approach the proportions anticipated, a good deal of sound work has been done, and but for the water shortage the output of the district would have been greater than for any year since the beginning of the war. Some 400 men were steadily at work in the vicinity of Cedar Creek, and several engineers who have examined the work have expressed the opinion that the ground is likely to pay well when more systematic methods of operation are adopted.

PREMIER MINE.—Some excitement has been caused by the announcement that the Premier company has offered the Selukwe company one million dollars, payable over two years, for its two-thirds interest in B. C. Silver Mines, Ltd. The Premier company holds the other one-third, and the Selukwe company refused to entertain less than five millions, payable over four years, a suggestion that did not interest the Premier company. The B. C. Silver Mines has installed a compressor and has started a tunnel; it also has let a contract for diamond-drilling to Boyle Brothers, of Spokane. [The most recent information is given in Review of Mining.—EDITOR.]

SOUTH AFRICA

September 12

DIAMOND REVIVAL.—The most popular topic of discussion in speculative mining circles, during the month, has been the "diamond revival" reflected by the cabled London quotations for leading shares. It is recognized that a great deal of leeway has to be made up in the diamond market and surplus stones disposed of, before diamond production can be resumed on a wide scale. At the same time, the darkness has been so deep that any gleam is welcome and stimulating. Reports from Kimberley have been conflicting, but actually it appears that De Beers Consolidated Mines are still chiefly on a relief-work basis and doing little constructive work excepting upon the new treatment plant. Certainly there has been no sign of productive operations in this quarter. The Premier mine, in the Transvaal, and Koffyfontein mines, in Orange Free State, are the only mines producing diamonds to any extent, outside the alluvial diggings.

Diamond ventures of interest at the moment are :—

(1) West End Diamond Mine, Postmasburg.—This concern has been referred to previously. It is one of those dubious properties, in the balance, with much to learn with regard to true mine grade and extent of pipe.

(2) Crown (old Lace) mine, Kroonstad, similarly in the balance, but now prominent as a gambling unit. Active development is in progress.

(3) Monteleo, Thor, and Theron mines, in the Driekopjes area, Orange Free State.—These properties produce good stones, but are not likely to become big factors in the diamond world.

(4) New Eland.—This mine, controlled by Sir Thomas Cullinan, has interest on account of a grade well above the average, and is expected to be producing again shortly. This mine, however, is also a small factor.

It is of interest that nothing new is prominent among local diamond speculations, though new discoveries will soon be

reported from old quarters if the revival shows any endurance.

RHODESIAN MINING AND THE UNION.—Mining issues are not prominent in the great discussion proceeding in Rhodesia between the Responsible Government party and those in favour of entering the union. The only criticisms by the Responsible Government Association, published in their manifesto of August 26, boil down to an expression of regret that the Union terms do not include the acquisition of the B.S.A. Company's mineral rights. Further comments under the head of "mining" are non-controversial, opinions being expressed that prospecting should be encouraged by the State, that the industry be freed as much as possible from all hampering restrictions, that the Mines Department should be extended in the direction of making it of more practical assistance to the mining man, and be made an effective medium for giving the prospector and small worker the benefit of the Government geological field work.

It is surprising that the Union's voluminous mining regulations were not made, once more, a target for satire.

SWAZILAND TIN.—The annual report of Swaziland Tin, Ltd., shows that this enterprise has now only one more year of life assured. During 1921–2, the company treated 233,000 cu. yd. by 8-inch hydraulic elevators, 99,558 yd. by hydraulicking, and 465,271 yd. by hand work, assisted by monitors and ground sluicing where possible. Working costs averaged 6d. per yard. Ground reserves are estimated at 880,000 cu. yd. at ½ lb. metallic tin per yard, and demanding higher costs than former ground. Swazi Tin will wind up with a creditable record of nearly 20 years production, marked by uphill progress, and two or three bonanza years, when high metal prices resulted in big profits.

OIL-SHALE VENTURES.—A new oil-shale venture has been formed with the title of "Orange River Oil-Shales Syndicate," with a view to testing a bed in the Karroo formation in the Northern Cape Province. Enough money has been subscribed to enable development to be commenced. There is little definite information available with regard to the thickness and contents of the shale. The bulk of South African deposits are thin compared with those of America and Scotland, and commonly poorer in crude oil. Work done on them, however, has been insignificant, and prospecting in various parts of the country may give the industry a more promising aspect than it has at present. Syndicates with a bona fide intention to employ subscriptions in practical work are to be encouraged, provided they make no attempt to deceive the public by issuing imaginative estimates of commercial results, regardless of the great expenditures in experimentation and equipment to be faced before any hope of success can be entertained. Other countries have been through the oil-shale phase of their education long ago and paid for the lessons South Africa has yet to learn.

The chief South African oil-shale concern is the African Oil Corporation, working in the Wakkerstroom district, S.E. Transvaal, A further shipment of shale (30 tons) has been sent recently to London for test purposes. The company is still active, in spite of discouraging reports from the industrial point of view, and announces a further exposure of shale yielding 40 galls. of crude oil over 17 inches and 15 gallons over 20 inches, with a 24-inch barren parting, still showing the narrow widths characteristic of the South African deposits known to date.

SOUTH AFRICAN MINERAL YIELD TO DATE.—The Government Mining Engineer has issued an interesting compilation of mineral production within the Union from the earliest records to the end of 1921. The table shows the limited range of products and again emphasizes the lack of progress in the base-metal industries. Valuations include :—

	£
Gold	717,000,000
Silver (Associated)	2,500,000
Diamonds	220,000,000
Coal	54,000,000
Copper	23,000,000
Tin	4,600,000

Copper and tin mining have fallen off seriously, and apart from the influence of the metal market, are waning industries.

No other product has reached a million sterling. Asbestos at £750,000 and lead at £124,000 have been disappointing, while iron ore, manganese, tungsten, zinc, corundum, graphite, iron pyrites, and magnesite are only remarkable for the small aggregate value of their declarations, which each fall short of six figures.

HEIDELBERG DISTRICT.—The geological report of Dr. A. W. Rogers upon the oft-

debated geological relations of the Heidelberg-Nigel district, has satisfactorily laid to rest a number of popular fallacies, without changing radically the interpretation of former geologists of standing. The Nigel Reef is determined as the base of the Upper Witwatersrand Beds and is traced through Varkensfontein, Bultfontein, Blesbok Valley, Noycedale, Maraisdrift, Rietpoort, and Poortje down to Steyns Kraal. The Edenkop mine of the Coronation Syndicate is located by Dr. Rogers in the Government Reef series.

MODEST COMPANY CAPITALIZATION.—Among the new company registrations is the "Quest Gold Mining Co., Ltd., Quest Mine, Buffelsdoorn, Klerksdorp. Capital, £480." The capitalization indicates a refreshing change, even though this novelty may be a turn to the extreme. It also represents one more mark of interest in small "banket" mines, so popular to-day from Witpoortje westward.

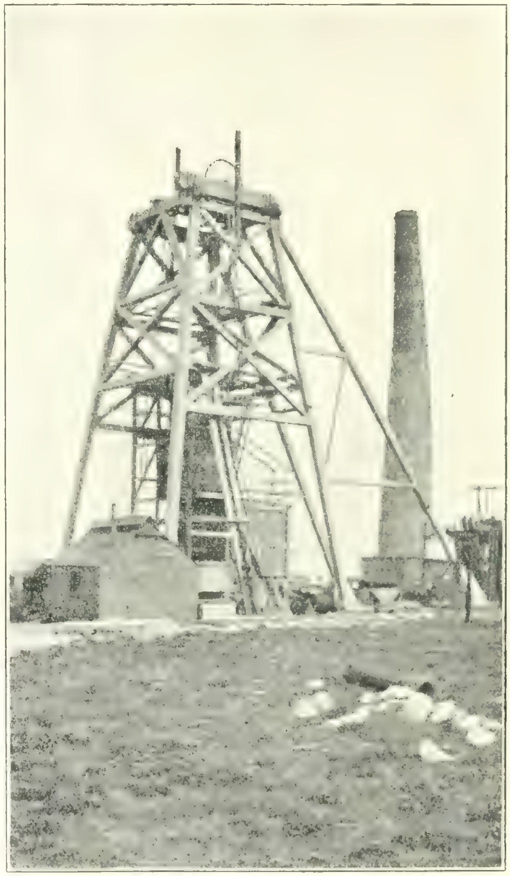
ZOUTPANSBERG AND KLERKSDORP MINING.—The report of a revival of activity in the Zoutpansberg district of the Northern Transvaal, where the Central Letaba Gold Mining Co., Ltd., is producing on a small scale, is good news. Over-centralization is the weakness of our mining industries. The gold deposits of the Zoutpansberg, in the same formation as those of Barberton, may possess several such opportunities for the small operating concern, especially when the men in charge are interested in results and can hope for substantial rewards for initiative and for the climatic risks of work in fever districts. The Letaba Co. reports crushing 130 tons for a yield of 140 ounces and to have traced a new shoot, giving promise of persistence. This may sound a small matter to discuss, but the reference serves to emphasize the extreme importance of even small beginnings toward the reopening of mines in neglected areas, of revealing the possibilities of reward for genuine working syndicates, and of generally stirring up interest in mine exploration on Rhodesian, independent lines.

In the same way, the action of certain mining engineers in taking control of the Africander mine, Klerksdorp, and bringing it to a producing basis, has very much wider significance than records of footage and assay values might indicate. They have proved the boldest of pioneers—in an old field of poor repute—and are believed to be finding rewards for their enterprise.

CAMBORNE

October 6.

UNEMPLOYMENT.—There is a slight improvement in the situation due to greater activity in china-clay and to emigration. During August a batch of 25 miners left for a South American gold mine, and it is now reported that arrangements have been made for sending 100 miners from the Camborne and Redruth areas to the Hollinger gold mine in Ontario. The Government Overseas department has consented to make a gift of two-thirds of the sum required to send these men out. The Cornish mines are not as yet taking any off the unemployment list, unless it be a few prospecting parties. South Crofty will probably be the first to reinstate its quota of men early in the New Year.



NEW SHAFT AT EAST POOL.

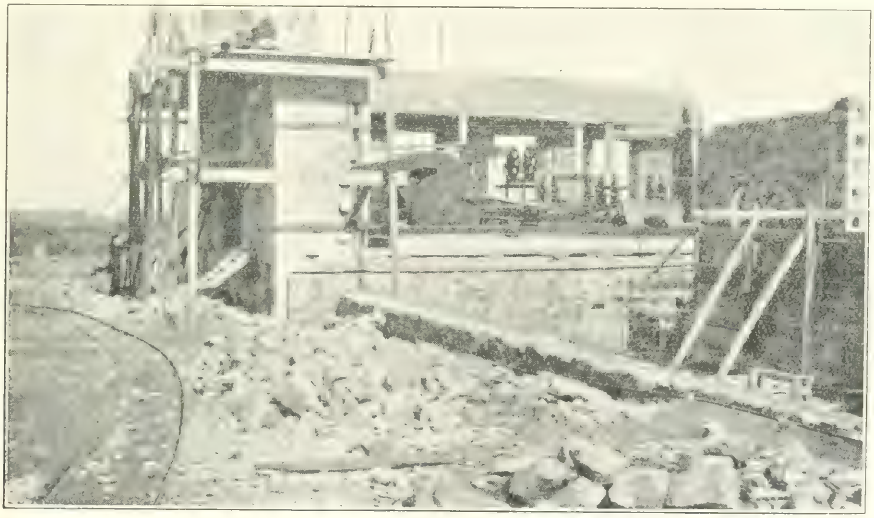
JOINT INDUSTRIAL COUNCIL.—This council, comprising representatives of employers and labour of the tin mining industry, held

a meeting at Camborne on September 22 with a view to discussing and ascertaining the conditions under which tin mines could reopen with the price of tin round about the present figure. It was pointed out that the whole question hinged on the cost per ton of ore raised. Yield per man was a vital factor and it was urged that if the men gave a good day's hard work the wages need not be low. This question of "tons per man" is of vast importance, and though a worker may not be exactly following the principles of ca'canny, unless the spirit of co-operation and personal interest exists and the man puts his back into his job, production rapidly falls and up goes the cost per ton. In this matter of costs Mr. Moreing ventured a figure of 20s. per ton at present prices of coal, explosives, materials, and labour. With metallic tin at £150 per ton expenses would be covered on a mine producing ore yielding 25 lb. of black tin per ton. With metallic tin at £125 ore yielding 30 lb. black tin would cover costs. With a view to showing the profit that can be realized he gave the following table for East Pool on its present milling capacity of 84,000 tons of ore per annum averaging 30 lb. of black tin per ton :—

Tin per ton.	Profit per annum.
£150	£17,200
£170	£30,700
£190	£44,200

No allowance has been made for arsenic or other by-products. Continuing, Mr. Moreing hoped to arrange for increasing the output at East Pool to 120,000 tons per annum. An average of 35 lb. black tin per ton is indicated by their developments.

Another point raised at the meeting was the question of railway freights. Where mines are pumping and operating by steam the most serious factor is the cost of coal. Coal purchased in Somerset at 12s. per ton at the pit's mouth cost 13s. to bring it to Camborne. It was decided to communicate with the Joint Industrial Council for the clay industry with the object of getting a reduction in railway freights, more particularly on coal.



New Winding Engine at East Pool in Course of Erection.

Dolcoath Mine.—Under the Trades Facilities Act the Treasury has guaranteed a loan, principal and interest, to Dolcoath of £50,000, under certain conditions, to enable them to carry out their scheme of opening up the lodes to the north known as the Roskears. The conditions imposed on the directors are reciprocal, and the shareholders will be asked to provide a like sum or more before the Treasury grant can become available.

A definite scheme whereby the proposed grant may be acquired satisfactory to both sides has been formulated and will be put before the shareholders at a meeting to be called in the immediate future.

South Crofty.—The 90-inch Cornish pumping engine at New Cooks Kitchen shaft is nearly completed and is expected

to commence working before the end of this month. This pumping scheme, for which the Trades Facilities Board guaranteed a loan of £30,000, is to deal with the bulk of the water from Tincroft and old East Pool mines. The pumping engine at Robinson's section will take charge of the South Crofty water from the bottom of the mine. It will be the end of the year before the underground work and finalities are completed and the water sufficiently well in hand to enable mining operations to re-start.

East Pool.—The new shaft is now down over 720 ft. The water trouble experienced in July has been completely overcome, thanks to the François cementation process, and the sinking is proceeding at record pace. The sinking is being carried out by means of Holman's hammer-drills. These machines have already accomplished over 700 ft. of sinking in both hard and soft ground. The rotating gear has been speeded up specially for this work and, considering that the depth of the holes drilled is in the vicinity of 5·5 ft. with 1 in. steel, they are doing excellent service. Spares, costs, and upkeep for these machines, of which there are 7 in constant use, averages around 4s. per day of four shifts of 6 hours each. When the cementation process is being applied these hammer-drills are called upon to drill 20 ft. holes, and they accomplish their work without any difficulty.

The shaft will shortly reach the first point where a cross-cut is to be put out to intersect the Rogers lode, after which similar cross-cuts will be driven at regular intervals as the shaft proceeds. As there is a large quantity of ground already opened up on the Rogers lode from the last working, and ready for stoping, milling operations should rapidly reach their full capacity when a start is made.

Levant Mine.—Indications point toward this mine soon entering the dividend list. Upwards of 12 tons of tin per month is the output from their battery of 5 Californian and 2 Nissen stamps. New plant is being erected, additions being made to the already up-to-date mill, as well as facilities for the economical transport and handling of the ore. Electric power for the surface plant is generated by two Belliss high-speed sets direct-coupled to two direct-current generators of about 100 k.w. each. Underground the mine is in a healthy condition. Levant should give a good account of itself in the near future.

Geevor Mine.—Cross-cutting is in progress from the Victory shaft to the Pig lode. Already some good finds en route are reported ; three carrying mostly copper and one good tin lode of above average values. In the Wethered section new ground has been opened up on the Pig lode, which is being stoped with hammer-drills. The values in this ground are also above the average. Geevor is fully equipped to deal with the large ore reserves and the new discoveries. Alterations and improvements have taken place in the mill during the last year, all with a view to economical milling and a closer saving of mineral. The mill is at present operating on the day shift only, but an increased tonnage crushed and an increased output of black tin is reported.

Fullers Earth.—At Treamble, near Perranporth, the great Perran iron lode contains an interesting deposit of fullers earth. This earth, which is of high grade and eminently suitable for oil refining and other uses to which fullers earth is applied, appears to be a decomposed "killas" and lies in direct contact with and immediately over a high-grade phosphoric iron ore. Negotiations are afoot to work this deposit where excellent physical facilities exist for its exploitation. The Great Western Railway has a branch line running on to the property, which also serves large ballast quarries in the vicinity. The track was removed during the war, and its reinstatement, which has already been urged, would prove a stimulus to both the fullers earth and other minerals.

PERSONAL

A. W. Ambrose has been appointed assistant director of the United States Bureau of Mines.

Dr. J. Mackintosh Bell recently paid a short visit to properties on Great Slave Lake.

A. H. Bromly has left for Mexico.

F. K. Borrow is on a visit to South America.

A. H. Collier has left for West Australia.

Dr. Davison is home from West Africa.

Nelson Dickerman will be in New York from Dutch Guiana during October.

Rowland C. Feilding left for Porcupine on the 14th inst.

Philip L. Foster has been examining properties in the Elbow Lake district of Northern Manitoba for the Exploration Company.

H. Gemmell is home from West Africa.

W. H. Goodchild has left for Kirkland Lake.

H. Lipson Hancock has resigned as manager of the Wallaroo and Moonta mines and is succeeded by William E. Slee.

J. P. Hutchins is here from the Continent.

R. H. Johnson has left for Nigeria.

G. A. KEENE has returned from South Africa.

H. LAVERS is expected from Australia.

DONALD M. LIDDELL has been appointed secretary of the Mining and Metallurgical Society of America.

FRANK C. LORING is expected from Toronto.

HUGH F. MARRIOTT notifies us that his address for future correspondence is: "Heids," Morland Close, Hampstead Way, London, N.W. 11.

WALTER McDERMOTT has moved his office from Moorgate Hall to 78, Coleman Street, London, E.C.2.

FRANK B. POWELL is here from Colombia.

THOMAS T. READ, of the United States Bureau of Mines, is visiting the St. John del Rey mine in Brazil.

FRANK REED has resigned the position of inspecting engineer for the New Zealand Mines Department, a position which he has held for sixteen years, and has commenced practice as a consulting engineer at Wellington, N.Z.

H. V. SMITH has left for Nigeria.

KENNETH TAYLOR, South African manager for the Climax and Sandycroft companies, is here from Johannesburg.

A. N. WAKEFIELD is retiring shortly from the position of resident manager for the Siamese Tin Syndicate.

P. A. WESTCOTT has returned from the Gold Coast.

J. E. CARNE died at Sydney last July. He joined the New South Wales Geological Survey in 1879, and continued in that service until he retired in 1919, after having been for some time Government Geologist. His reports on the mineral deposits of New South Wales have proved most valuable, and continue to be classics. He was a judiciously hard worker, and a conscientious observer of details, and as an official he was always helpful to the humblest applicant for information.

TRADE PARAGRAPHS

THE SULLIVAN MACHINERY CO., of Chicago (London Office: Salisbury House, E.C. 2), send us their booklet No. 123, dealing with road-building plant.

The WESTINGHOUSE ELECTRIC & MANUFACTURING CO., of East Pittsburgh, U.S.A., send us their Circular No. 1,648, describing in detail their modern designs of electric locomotives for mines. A great variety of types are illustrated, and their special applications are discussed.

RUSTON & HORNSBY, LTD., of Lincoln, announce that they have received orders for thirteen drag-line excavators from S. Pearson & Son, Ltd., to be used in connexion with the new Soudan irrigation scheme for the purpose of digging the canals. The machines will be mounted on caterpillar bases.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, send us the *Edgar Allen News* for August. This contains a useful illustrated article on the design and construction of dredge buckets, in which the firm's manganese steel is used in the wearing parts. It also contains notes on the lubrication of crushing and grinding machinery and on stone-working by machinery.

D. H. & G. HAGGIE, LTD., of the Wearmouth Rope Works, Sunderland (London Office: Dashwood House, E.C. 2), have issued an elaborate catalogue describing their steel wire ropes in locked coil, flattened strand, Lang's lay, and ordinary lay. The firm are well known in mining, oil, and logging circles, and also for aerial ropeways. Among the illustrations in the catalogue is one showing wire ropes supplied to the De Beers mines.

G. A. HARVEY & CO. (LONDON), LTD., of Woolwich Road, London, S.E. 7, send us particulars of their "Universal" steel cupboard, which will prove serviceable to mining men in all parts of the world. The cupboard has many advantages over those made of wood; it is of greater strength and security, and is proof against fire, rot, damp, and vermin. The height is 72 in., the width 24 in., and the depth 18 in. A high-class lock is fitted, and the steel is given a best-quality finish in stove enamel of olive-green shade.

THE METROPOLITAN-VICKERS ELECTRICAL CO., LTD., of Trafford Park, Manchester, and 4, Central Buildings, Westminster, send us a pamphlet describing the 1,350 h.p. straight alternating-current geared electric winder erected at the Hilton colliery. This pamphlet gives useful information relative to winding problems. The work described was done in association with Walter Dixon & Co., of Glasgow, the consulting engineers to the colliery company. We have also received from the Metropolitan-Vickers Co. their Cosmos calendar and show-card, and their domestic appliance show-card giving particulars of their lighting and heating systems.

DANIEL ADAMSON & CO., LTD., of Dukinfield, near Manchester, have received an order for one of their latest patent electrically-driven crude sewage lifting plants for Messrs. Cropper's new factory at Thatcham, Berks. The design of this installation is of special interest, in that the motor-driven compressors deliver the air direct into the sewage ejectors. The inventors claim that the absence of any air storage receiver with its inseparable leakage losses is an important factor, for it means no unnecessary compressed air will be used, and incidentally the horse power of the motors and the consumption of current is reduced 50%.

JAMES GORDON & CO., LTD., announce the establishment of their business as water-power engineers at Windsor House, Kingsway, London, W.C. 2. In 1920, this business was absorbed by the English Electric Co., Ltd., and Mr. Gordon was made head of that company's water-power department. This connexion has since been dissolved, and Mr. Gordon now resumes independent practice. He has formed his business into a limited company, and has also acquired the water-power business of John Turnbull & Co., of Glasgow. The new firm is issuing a detailed catalogue dealing with turbines and other water-power plant, suitable specially for low and medium heads.

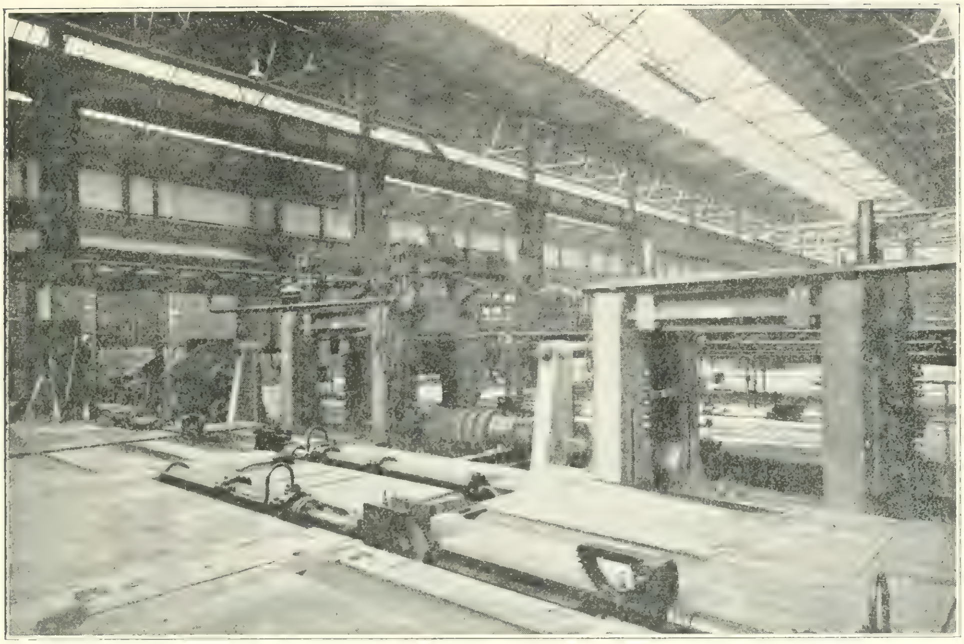
NOBEL INDUSTRIES, LTD., of Nobel House, Buckingham Gate, London, S.W. 1, have issued a sixteen page booklet dealing with the reduction of heavy pieces of metal to smaller dimensions by means of explosives. Methods recommended for cutting steel plates and cast metal by plaster shot and by blasting are described in detail, tables of quantities usually required giving much essential information. The dispersal of wrecks is also dealt with, while hints are given on the deepening of rivers, breaking concrete foundations, and well blasting. The precautions to be used to prevent flying of debris are also described. This booklet is supplementary to others of the same series which deal with blasting explosives and

accessories, blasting in collieries, and ground clearing.

BRUNTONS, steel wire manufacturers, of Musselburgh, Scotland, have recently placed on the market a mechanically operated torsion machine for testing wire. The torsion test usually included in wire specifications has hitherto been taken in in a hand-operated machine ; as the operator does not give an even torque to the machine when revolving it by hand, and as one operator works quicker than another, there has been some difficulty in the past in getting the torsion at various works to compare. The firm's automatic torsioning machine obviates this drawback. It is operated by a belt or a motor which revolves the wire at both ends in opposite directions at a uniform speed. The machine is so arranged that various weights can be put on so that it can be torsioned under tension. Readers who use wire and wire ropes will find this machine of interest.

EXTENSIONS AT HADFIELDS

HADFIELDS, LTD., of the Hecla and East Hecla Works, Sheffield, continue to expand their works on a peace footing. They are now in an excellent position for dealing with post-war work, that is, general commercial work, including the production of steel castings and forgings of all kinds on a very large scale. Their steel foundry buildings alone occupy a total area of no less than 20 acres. The steel-making facilities comprise a plant of the most modern type of open hearth steel furnaces, having an output capacity of about 1,200 tons per week, together with an electric furnace plant which during the war melted not far short of a thousand tons of steel per week. With their further special steel plant for producing steel under the Hadfield system, their grand total output capacity of steel reaches the considerable figure of 200,000 tons per annum. It is only natural that the company, after devoting so many years to the production first of sound steel castings and ingots and secondly of manganese, low-hysteresis, and other special steels in the form of castings and forgings of all types, should add the rolling and forging of special alloy steels to their other facilities. With this end in view the firm have recently laid down three very complete electrically driven rolling mills, including a reversing 28 in. blooming and finishing mill, an 11 in. and a 14 in. bar mill, all of the most modern and improved types. The two smaller mills are used for rolling billets to the various commercial sizes of round and square bars. They have proved very useful also for the production of special alloy high tensile steels for motor-cars and commercial vehicles, spring steel, and other special steels. The new 28 in. mill is the first having for one of its main objects the production of " Era " manganese steel rails of various sections. The total area covered by the new rolling mill scheme is 175,000 sq. ft., or four acres, the rolling mill shop itself occupying an area of 80,000 sq. ft., or 1·57 acres. If the area of the smaller mill is also included the total space covered is considerably over five acres. The building is equipped with travelling cranes of 20 tons and 35 tons capacity. The open hearth ingots are conveyed hot to the rolling mill building. The furnaces and soaking pit embody all the latest modern improvements, and are of the gas-fired, reversing, regenerative type. The gas for the continuous furnaces and soaking pit is supplied by five gas producers, each capable of gasifying 10 cwt. of coal per hour. A gravity roller track links the soaking pit with the continuous furnaces. The main control platform on the approach side spans the entire width of the mill. The mill is capable of rolling down 15 in. square steel ingots 5 ft. long having a weight of 25 cwt., and reducing them at one heat to 2½ in. square billets. The normal output will be approximately 1,500 tons per week, or say 15 tons per hour, with a maximum output of 20 tons per hour for occasional short periods. The mill will also roll Hadfield " Era " manganese steel ingots into rails up to the heaviest section in demand, having a maximum length of about 55 ft. rolled. The 28 in. mill comprises one cogging and one finishing stand. The cogging rolls are 28 in. in diameter and 7 ft. long and the finishing rolls 28 in. in diameter and 6 ft. 6 in. long. The total weight of the mill is about 1,600 tons, that is, including the electrical equipment, weighing approximately 400 tons. The main rolls of steel were manufactured by Hadfields and are of their special quality forged steel with machined fluted wobbler ends. The hydraulic shears are of the up-cutting type complete with hydraulic intensifier arranged for a maximum power of 1,000 tons and capable of shearing " Era " manganese steel blooms when hot up to 10 in. square. The hot saw is of the horizontal sliding type arranged with a blade of 60 in. diameter and driven by a 75 h.p. motor. The mill motor has a rating of 3,200 h.p. and a maximum rating of 11,600 h.p. It is capable of exerting a constant torque of 125 tons-feet from standstill to 60 revolutions per minute in either direction, and gives a constant horse-power of 3,200 between the speeds of 60 and 120 revolutions per minute. The overload capacity corresponds to a torque of 453 tons-feet between standstill and 60 revolutions per minute ; and 11,600 h.p. between the speeds of 60 and 120 revolutions per minute. The cast steel flywheel, which was made by Hadfields, is of the built-up type, 11 ft. 6 in. in diameter and weighing 30 tons. The flywheel set, which consists of 1,800 h.p. 3-phase motor and on the same shaft two dynamos of 6,000 h.p. and farther along the shaft a 30-ton flywheel, is interposed between the power lines of the Sheffield Corporation and the main mill motor in order to supply the large machinery demand for power. The main mill motor is capable of being reversed from full-speed in one direction to full-speed in the other direction in three or four seconds. The necessary appliances for carrying out the requisite treatment of the Hadfield " Era " Manganese steel rails are arranged at the side of the ingoing run-out by which the rolled material is conveyed to the saw. A noteworthy feature is an electrical telegraph system established between the control platform and the electrical equipment house by which orders can be communicated between the mill driver on the platform and the attendant in the electrical equipment house. The hydraulic water service to the mill is arranged for a working pressure of two tons per inch and is supplied by a set of three throw-pumps driven by a 175 h.p. motor. The floor surrounding the mill is finished off in a neat manner, and the live roller gear which at the finished mill is 320 ft. long being below the floor, and the latter presenting an even plated surface all over with the exception of the live rollers which necessarily project slightly above



THE NEW ROLLING MILL AT HADFIELDS' EAST HECLA WORKS, SHEFFIELD.

the floor level. Provision is made for turning the main rolls in one bay of the mill where there is ample space for the storage of the rolls. There is no more modern plant of its kind either at home, in America, or elsewhere. There are those who have said it is necessary to go to America and Germany for the most modern and systematic steel plants, but Hadfields rightly urge that this is incorrect, and that British engineering is quite capable of designing, manufacturing, and running rolling mill and steel forging plants second to none in the world.

METAL MARKETS

COPPER.—All markets were influenced at times during the month of September by adverse movements in sentiment directly attributable to the cloudy international political situation, and particularly the threat of war in the Orient. Nevertheless, such setbacks were merely temporary, and the non-ferrous metals in every case showed considerable inherent stability. Standard copper remained fairly steady during the major portion of the month, but closed with quite a firm tone. This firmness was partly caused by the strength of the dollar exchange, which naturally tended to harden the London parity of electrolytic copper, but the improving demand for copper in this country was also not without its influence in giving the market a buoyant aspect. Particularly noticeable was the better inquiry for refined descriptions, this being probably due to the growing scarcity of scrap metal in the country. A fair demand was seen from the Continent, both France and Italy interesting themselves, while Germany was not an entirely negligible buyer, despite the fact that the latest fall in the mark had seriously disorganized her capacity to purchase. As soon as internal conditions in Germany have readjusted themselves to the new level of values, it is to be expected that that country will again feature as a buyer of note. Conditions in America underwent some improvement, thanks to the settlement of the protracted labour disputes in the United States, and the outlook is hopeful in view of the fairly strong position of producers and the good scale of domestic consumption there. Skilled labour appears to be short, and, consequent on the higher wages offered, mining costs in America seem likely to exhibit an advancing tendency in the near future. The market for electrolytic in New York was barely steady during the month, however, the quotation being about 13·95 cents.

Average price of cash standard copper: September, 1922, £63 3s. 4d.; August, 1922, £63 16s. 9d. September, 1921, £68 0s. 11d.; August, 1921, £68 12s. 8d.

TIN.—The market did not present a very good appearance during the beginning and middle of September, interest being somewhat quiet. Neither English nor Continental demand was very lively, and the statistics published early in the month, which showed that visible supplies had increased by about 1,000 tons to some 22,000 tons, although received by the market without much perturbation, did not assist optimism. Towards the end of the month American buying manifested itself, and as a result values firmed up appreciably. This was a welcome development, as it had been evident for some time past that if the market was to remain at all healthy the United States would have to come in as a serious buyer instead of merely nibbling on a small scale. The better industrial position in the United States naturally favours fresh buying by that country. The Straits sold fairly steadily during the month, and it was worthy of note that holders there took the opportunity of making good

London Daily Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long Ton

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
Sept.	£ s d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
11	63 0 0 to 63 2 6	63 7 6 to 63 10 0	70 15 0 to 71 5 0	71 5 0	— —
12	63 2 6 to 63 5 0	63 10 0 to 63 12 6	70 15 0 to 71 5 0	71 5 0	66 0 0 to 68 0 0
13	63 5 0 to 63 7 6	63 12 6 to 63 15 0	71 0 0 to 71 10 0	71 10 0	— —
14	63 7 6 to 63 10 0	63 15 0 to 63 17 6	71 10 0 to 72 0	72 0 0	— —
15	63 2 6 to 63 5 0	63 10 0 to 63 12 6	71 10 0 to 71 15 0	71 15 0	66 0 0 to 68 0 0
18	62 17 6 to 63 0 0	63 7 6 to 63 10 0	71 10 0 to 71 15 0	71 15 0	— —
19	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 5 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
20	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 5 0 to 71 10 0	71 10 0	— —
21	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 0 0 to 71 5 0	71 5 0	— —
22	62 17 6 to 63 0 0	63 7 6 to 63 10 0	71 0 0 to 71 5 0	71 5 0	66 0 0 to 68 0 0
25	63 5 0 to 63 7 6	63 15 0 to 63 17 6	71 0 0 to 71 10 0	71 5 0	— —
26	63 2 6 to 63 5 0	63 15 0 to 63 17 6	71 0 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
27	63 7 6 to 63 10 0	63 17 6 to 64 0 0	71 5 0 to 71 15 0	71 15 0	— —
28	63 12 6 to 63 15 0	64 5 0 to 64 7 6	71 10 0 to 72 0 0	72 0 0	— —
29	63 17 6 to 64 0 0	64 7 6 to 64 10 0	71 10 0 to 72 10 0	72 10 0	56 0 0 to 68 0 0
Oct.					
2	63 12 6 to 63 15 0	64 5 0 to 64 7 6	71 10 0 to 72 10 0	72 10 0	— —
3	63 10 0 to 63 12 6	64 2 6 to 64 5 0	71 10 0 to 72 5 0	72 5 0	66 0 0 to 68 0 0
4	63 5 0 to 63 7 6	63 17 6 to 64 0 0	71 5 0 to 72 0 0	72 0 0	— —
5	63 0 0 to 63 2 6	63 10 0 to 63 12 6	71 5 0 to 72 0 0	72 0 0	— —
6	62 10 0 to 62 12 6	63 2 6 to 63 5 0	71 5 0 to 72 0 0	72 0 0	66 0 0 to 68 0 0
9	63 2 6 to 63 5 0	63 12 6 to 63 15 0	71 0 0 to 71 10 0	71 10 0	— —
10	63 0 0 to 63 2 6	63 12 6 to 63 15 0	71 0 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0

sales at the higher figures commanded toward the end of September. Neither Batavia nor China featured as important sellers, and the former appeared to be holding off in anticipation of better figures later on.

Average price of cash standard tin: September, 1922, £160 2s. 8d.; August, 1922, £160 1s.; September, 1921, £156 17s. 6d.; August, 1921, £155 8s. 4d.

Lead.—There was a somewhat easy tendency in the first part of the month, and it seemed as if rather heavier arrivals of fresh metal were having their natural effect. As a result of the quietness of demand and the freer offerings of early delivery, the backwardation at one time diminished to a mere 7s. 6d. Toward the end of the month, however, the tone became firmer, possibly partly owing to the usual bear covering, but also partly because of a rather better inquiry. Consumption both in the United Kingdom and on the Continent at the end of September seemed to be fairly satisfactory, some of the home works being busy on Post Office contracts. The immediate outlook does not seem to indicate much change in the position, unless unforeseen developments arise, but considerable obscurity attends the question of fresh supplies. Spain has not latterly featured as so large a shipper to this country as used to be the case. On the other hand, pretty fair quantities continue to come in from Australia, while a certain amount of Mexican lead is arriving in Europe. There is a possibility of increased shipments from Mexico, as a result of the new United States tariff, which will probably divert metal to Europe which might otherwise have been exported to the States.

Average price of soft foreign lead: September, 1922, £23 16s. 3d.; August, 1922, £24 3s. 10d.; September, 1921, £22 19s. 5d.; August, 1921, £23 5s. 1d.

Spelter.—The market exhibited quite a firm aspect during September, and general conditions underwent little alteration. Holders continued reserved, and the quantity of metal offering from the various Continental producers was not very appreciable. The output of English makers and the shipments from the Risdon works in Tasmania were insufficient to restore the balance between supply and demand, in view of the reviving tendency manifest in the galvanizing industry during the month, and prices consequently hardened. Sentiment received a further fillip from the news that in the United States stocks were down to about 21,000 tons, a substantial reduction having been effected in August despite the fact that the labour disputes were then still unsettled. Belgian output has latterly shown an increasing tendency, and it was noticeable at one time that producers there were more inclined to offer metal for forward shipment. The various Franco-German agreements recently made with regard to reconstruction in the French devastated areas are expected to create a larger Continental demand for zinc sheets, already fairly substantial. All the signs are therefore in favour of a moderately good demand in the near future, while it is not yet certain whether the increasing tendency of output in the various producing countries will keep pace with the expansion in demand. Ruling quotations can hardly be called cheap, but it is, nevertheless, doubtful whether they will be seriously modified just yet.

Average price of spelter: September, 1922, £31 8s. 8d.; August, 1922, £30 16s. 3d.; September, 1921, £25 10s. 8d.; August, 1921, £25 8s.

Zinc Dust.—The market is very steady, Australian high-grade being priced at £50, while American 92 to 94% and English 90 to 92% are quoted at £47 10s. per ton.

Antimony.—A somewhat firmer tone has been in evidence, and although ordinary brands of English regulus are unchanged at £27 to £29 10s. per ton, special brands are harder at £33 15s. to £35. The cheapest parcels of foreign material seem to have been absorbed, and sellers of this description now ask £25 and upwards in warehouse.

Arsenic.—With demand still slack, the market keeps firm on short supplies. Cornish white is quoted at £46 10s. per ton delivered London for 99%.

PRICES ON THE LONDON METAL EXCHANGE.
Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	d.	d.	s. d.	Sept.
24 5 0 to 23 7 6	25 10 0	31 10 0 to 30 15 0	159 5 0 to 159 7 6	159 15 0 to 159 17 6	35¼	35¼	92 6	11
24 2 6 to 23 7 6	25 10 0	31 10 0 to 30 15 0	158 12 6 to 158 15 0	159 10 0 to 159 12 6	35⅜	35⅜	92 6	12
24 0 0 to 23 5 0	25 5 0	31 12 6 to 30 17 6	159 2 6 to 159 5 0	160 5 0 to 160 7 6	35¼	35⅛	92 9	13
24 0 0 to 23 7 6	25 5 0	31 12 6 to 30 17 6	159 10 6 to 159 12 6	160 10 0 to 160 12 6	35⅛	35⅛	93 6	14
24 2 6 to 23 7 6	25 5 0	31 12 6 to 30 17 6	159 2 6 to 159 5 0	160 5 0 to 160 7 6	35⅛	35⅛	93 1	15
24 2 6 to 23 10 0	25 5 0	31 12 6 to 30 17 6	159 0 0 to 159 2 6	160 2 6 to 160 5 0	35¼	35⅛	93 4	18
24 0 0 to 23 7 6	25 5 0	31 12 6 to 30 17 6	158 15 0 to 158 17 6	159 17 6 to 160 0 0	35½	35⅜	93 4	19
23 17 6 to 23 6 3	25 5 0	31 10 0 to 30 18 9	159 0 0 to 159 2 6	160 5 0 to 160 7 6	35¾	35⅜	93 2	20
23 15 0 to 23 5 0	25 5 0	31 17 6 to 31 5 0	160 10 0 to 160 12 6	161 15 0 to 161 17 6	35¼	35⅛	93 0	21
23 15 0 to 23 7 6	25 5 0	32 7 6 to 32 0 0	161 0 0 to 161 2 6	162 5 0 to 162 7 6	35¼	35¼	93 2	22
23 18 9 to 23 11 3	25 5 0	32 7 6 to 32 2 6	161 10 0 to 161 12 6	162 15 0 to 162 17 6	35⅜	35¼	93 2	25
23 18 9 to 23 11 3	25 5 0	32 2 6 to 31 15 0	161 5 0 to 161 7 6	162 10 0 to 162 12 6	35⅜	35¼	93 5	26
24 2 6 to 23 12 6	25 10 0	32 5 0 to 32 0 0	160 17 6 to 161 0 0	162 2 6 to 162 5 0	35 5/16	35¼	93 5	27
24 15 0 to 24 2 6	26 0 0	32 7 6 to 32 0 0	161 12 6 to 161 15 0	162 15 0 to 162 17 6	35 5/16	35¼	93 10	28
24 17 6 to 24 5 0	26 0 0	32 10 0 to 32 2 6	163 7 6 to 163 10 0	163 10 0 to 164 12 6	35 5/16	35¼	93 10	29
								Oct.
24 12 6 to 24 0 0	26 0 0	32 12 6 to 32 5 0	164 7 6 to 164 10 0	165 7 6 to 165 12 6	35 7/16	35 5/16	94 0	2
25 0 0 to 24 7 6	26 5 0	32 17 6 to 32 8 9	164 15 0 to 164 17 6	165 12 6 to 165 15 0	35 7/16	35 7/16	93 9	3
25 2 6 to 24 10 0	26 5 0	33 0 0 to 32 7 6	163 5 0 to 163 7 6	164 7 6 to 164 10 0	35⅜	35 5/16	93 8	4
25 2 6 to 24 6 3	26 5 0	33 0 0 to 32 7 6	163 10 0 to 163 12 6	164 10 0 to 164 12 6	35¼	35 3/16	93 1	5
25 0 0 to 24 2 0	26 5 0	33 0 0 to 32 7 6	163 10 0 to 163 15 6	164 12 6 to 164 17 6	35 5/16	35 1/16	93 4	6
25 2 6 to 24 7 6	26 5 6	33 0 0 to 32 7 6	163 17 6 to 164 0 0	165 2 6 to 165 5 0	35 3/16	35 1/16	93 1	9
25 5 0 to 24 5 0	26 10 0	32 17 6 to 32 5 0	165 2 6 to 165 5 0	165 5 0 to 166 7 6	35⅛	35	93 4	10

BISMUTH.—A good demand has caused prices to advance to 10s. per lb., at which figure considerable business is still being booked.

CADMIUM.—Sales are very moderate, with quotations unaltered at 5s. 6d. to 5s. 9d. per lb.

ALUMINIUM.—The home market is steady, with a moderate demand, quotations being £100 for home, and £105 for export. Continental is rather dearer, Norwegian being the cheapest at about £85 to £90 f.o.b.

NICKEL.—A further reduction of £5 has been made, making quotations £140 per ton for home and export.

COBALT METAL.—Under-quoting seems to have stopped, but the market is still quiet. The official quotation remains at 12s. per lb.

COBALT OXIDES.—A considerable expansion of business has developed, but prices are unaltered at 9s. per lb. for black and 10s. for grey.

PLATINUM.—Shortage of supplies coupled with a good demand have forced prices up to about £22 to £23 for sponge, and £26 per oz. for manufactured material.

PALLADIUM.—Business is very moderate, with raw about £14 to £15, and sheets and wire, etc., about £17 to £19 10s. per oz.

QUICKSILVER.—Values firmed up considerably at one time, £13 10s. to £13 15s. being quoted, but the month closed easier, on heavy arrivals, at about £13 per bottle for spot.

SELENIUM.—The market for powder has been quite active recently, but quotations remain at about 7s. 9d. per lb.

TELLURIUM.—A quiet tone continues, with quotations unaltered at 40s. per lb.

MANGANESE ORE.—There is not much fresh business passing, the Indian output being pretty well booked for this year. The price is about 1s. 2½d. per unit c.i.f. Caucasian is neglected, with ordinary grades about 1s. 2d. per unit c.i.f.

CHROME ORE.—There is a good demand, and stocks are short. Indian and Rhodesian 48 to 50% are quoted at £4 to £4 5s. per ton c.i.f.

SULPHATE OF COPPER.—The present price for both home and export is £26 10s. to £27 per ton.

TUNGSTEN ORE.—Spot material is scarce at 14s. 3d. to 14s. 6d. per unit, with forward shipment about 13s. 9d. to 14s.

MOLYBDENITE.—Business continues on a small scale, with 85% MoS_2 quoted at about 42s. 6d. to 45s. per unit c.i.f., although some sellers ask more.

SILVER.—The market remained steady during September, there being no movement of note whatever. The price of spot bars opened at 35⅛d. on the 1st, advanced to 35⅝d. on the 5th, relapsed to 35⅛d. on the 6th, and subsequently fluctuated between 35⅛d. and 35½d. during the remainder of the month. India was a somewhat indeterminate buyer, while China sold spasmodically. Business was on a rather small scale. The price closed at 35⅝d. on September 30.

GRAPHITE.—The market is dull, with 85 to 90% Madagascar nominal at £12 to £13 per ton, c.i.f.

IRON AND STEEL.—During the month prices of British pig iron advanced several shillings per ton, owing to the continued demand from both the United States and Canada, and at one time as much as 95s. was being asked for No. 3 Cleveland G.M.B. With the American coal strike over, however, fresh demand from that quarter has subsided a little, and in consequence makers are disposed to accept about 2s. 6d. below the highest price asked. Another furnace has been put into operation, but there is a general hesitancy on the part of producers to make any material increase in output owing to the high prices being asked for fuel. Home consumers, likewise, have been reluctant to buy more than sufficient to cover urgent requirements. Hematite commenced weak, but stiffened up a little on a renewal of home and export demand on a moderate scale, and East Coast mixed numbers ruled from about 88s. to 91s. There has been no fresh feature of interest in the manufactured iron and steel trade, business being slow to materialize, and prices generally show no change. One or two substantial contracts for certain work have been placed here, however, and some steel works will naturally benefit thereby.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of
	Oz.	Oz.	Oz.	Gold per oz.
				s. d.
September, 1921	674,157	16,939	691,096	110 0
October	690,348	17,477	707,825	103 0
November	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921	7,924,534	190,052	8,114,586	—
January, 1922				95 6
February	594,788	44,940	639,728	92 6
March				94 0
April	493,402	17,936	511,338	92 0
May	612,702	17,083	629,786	92 0
June	658,032	17,665	675,697	92 6
July	713,068	17,567	730,635	92 0
August	734,438	18,052	752,490	92 0

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
June 30, 1921	168,152	14,704	1,317	184,173
July 31	166,999	14,688	1,246	182,933
August 31	169,008	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,410	13,465	1,217	191,092
December 31	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169
June 30	170,464	12,117	1,211	183,792
July 31	172,886	12,371	1,211	186,468
August 31	175,054	12,270	1,219	188,543

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
August, 1921	2,050,722	37 3	25 4	11 11	1,226,282
September	1,997,086	36 8	25 2	11 6	1,151,127
October	2,041,581	34 4	24 9	9 7	981,597
November	2,007,617	34 6	24 9	9 9	978,931
December	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922 / February / March	1,624,333	33 10	49 0	15 2*	1,233,033*
April	1,414,843	31 7	24 3	7 4	519,365
May	1,772,793	31 4	22 8	8 8	767,533
June	1,882,837	31 10	22 8	9 2	862,575
July	2,057,895	31 0	21 1	9 11	1,048,727

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May	46,266	48,744	53,920
June	45,054	49,466	55,614
July	46,208	51,564	54,191
August	48,740	53,200	56,037
September	45,471	52,436	—
October	47,343	53,424	—
November	46,782	53,098	—
December	46,190	55,968	—
Total	552,498	591,525	433,686

Transvaal Gold Outputs.

	July		August	
	Treated Tons	Yield Oz.	Treated Tons	Yield Oz.
Aurora West	9,500	£12,988*	11,000	£13,637
Brakpan	64,500	26,303	64,000	25,941
City Deep	88,500	38,480	89,000	38,106
Cons. Langlaagte	41,100	£53,345*	45,200	£56,927*
Cons. Main Reef	52,100	20,424	53,000	19,193
Crown Mines	214,000	62,572	226,000	68,178
D'rb'nRoodepoortDeep	31,000	10,731	31,800	10,871
East Rand P.M.	119,000	30,559	125,000	31,580
Ferreira Deep	30,500	8,637	34,000	9,857
Geduld	46,300	16,359	46,800	16,480
Geldenhuis Deep	53,222	13,847	54,650	13,788
Glynn's Lydenburg	3,276	6,662§	3,862	£7,440§
Goch	17,500	£17,634*	17,500	£17,477*
Government G.M. Areas	141,000	£283,025*	150,000	£292,744*
Kleinfontein	47,600	12,345	47,900	11,853
Knight Central	32,000	6,447	32,500	6,472
Langlaagte Estate	49,350	£66,047*	51,300	£73,928*
Luipaard's Vlei	19,323	£19,206*	21,000	£21,189*
Meyer & Charlton	15,000	£38,506*	15,200	£39,524*
Modderfontein, New	108,000	49,656	112,000	52,671
Modderfontein B	62,000	34,379	62,000	33,137
Modderfontein Deep	43,200	23,408	44,800	24,071
Modderfontein East	26,300	10,713	27,000	11,747
New Unified	11,200	£12,148*	11,900	£11,361*
Nourse	47,700	14,753	48,000	15,026
Primrose	19,100	£19,490*	20,200	£20,732*
Randfontein Central	133,500	£189,616*	157,000	£209,834*
Robinson	17,000	5,687	18,300	6,049
Robinson Deep	68,400	20,963	70,500	22,955
Roodepoort United	8,650	£7,863*	—	—
Rose Deep	50,500	12,625	53,700	12,745
Simmer & Jack	48,800	10,735	53,700	11,659
Springs	41,400	19,230	48,000	21,477
Sub-Nigel	10,400	5,970	11,000	5,826
Transvaal G.M. Estates	15,940	£23,623§	16,170	£24,965§
Van Ryn	34,300	£44,626*	34,900	£45,307*
Van Ryn Deep	55,000	£120,865*	57,200	£130,126†
Village Deep	54,600	17,667	57,600	18,048
West Rand Consolidated	34,500	£44,366*	34,300	£44,755*
Witw'tersr'nd (Knights)	46,200	£53,845*	48,000	£55,925*
Witwatersrand Deep	42,350	12,997	37,200	12,739
Wolhuter	33,700	8,010	32,100	7,989

* £4 12s. per oz. § £4 10s. per oz.

Rhodesian Gold Outputs.

	July		August	
	Tons	Oz.	Tons	Oz.
Cam & Motor	15,000	5,604	15,300	5,656
Falcon	16,850	2,862*	16,572	3,061‖
Gaika	—	—	—	—
Globe & Phœnix	6,446	6,774	6,370	6,689
Jumbo	1,450	492	1,450	498
London & Rhodesian	3,423	£4,662	2,981	£3,396
Lonely Reef	5,560	3,975	5,550	4,039
Planet-Arcturus	5,900	2,323	6,100	2,660
Rezende	6,100	2,940	6,100	2,940
Rhodesia G.M. & I.	229	179	—	
Shamva	56,500	£37,471§	54,950	£37,179§
Transvaal & Rhodesian	1,520	£4,382†	1,580	£5,057†

* Also 274 tons copper. † At par. ‖ Also 297 tons copper.
§ Gold at £4 10s. per oz.

West African Gold Outputs.

	July		August	
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,720	£13,875*	7,710	£12,609*
Abosso	7,015	2,831	7,010	2,844
Ashanti Goldfields	7,800	5,391	7,808	6,522
Obbuassi	555	446	513	435
Prestea Block A	8,382	£15,738*	7,666	£15,207*
Taquah	2,500	1,327	2,453	1,304

* At par.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
December, 1921 ...	451	53,348	53,799	228,522
January, 1922	329	37,851	38,180	162,177
February	926	41,194	42,120	178,913
March	180	42,842	43,022	182,745
April	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June	136	49,158	49,294	209,386
July	366	42,774	43,140	183,247
August	1,051	48,638	49,689	211,064
September	—	46,398	46,398	197,085

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	oz.	oz.	oz.	£
January .	38,181	4,411	448	11,855
February.	42,121	8,063	1,200	12,325
March ...	43,022	11,717	1,069	12,960
April	46,394	4,186	6,219	6,589
May	39,725	10,049	7,636	13,100
June.....	49,294	12,058	12,181	6,784
July	43,140	9,966	6,906	4,907
August...	—	—	—	—
September	—	—	—	—
October .	—	—	—	—
November	—	—	—	—
December	—	—	—	—
Total ..	301,877	60,453	35,749	68,520

Australasian Gold Outputs.

	July		August	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	5,993	8,745‖	6,350	7,924‖
Blackwater (N.Z.)	3,694	7,443*	3,677	7,475*
Gold'n Horseshoe (W.A)	9,648	5,362‡	9,708	5,450‡
Grt Boulder Pro. (W.A.)	10,024	27,316‖	11,678	26,859‖
Hampton Celebr. (W.A.)	1,006	1,856‖	1,090	1,900‖
Ivanhoe (W.A.)	16,070	6,279‡	16,869	6,015‡
Lake View & Star (W.A.)	—	—	4,163	12,235*t
Menzies Con. (W.A.) ..	1,960	3,462	2,080	4,026
Oroya Links (W.A.) ...	3,321	15,082†s	2,802	15,383†‖
South Kalgurh (W.A.) .	6,821	11,936‖	7,446	12,437
Waihi (N.Z.)	15,342	4,419‡ 29,577§	15,463	4,655‡ 23,081§
,, Grand Junc'n (N.Z.)	—	—	—	—

* Including premium ; † Including royalties ; ‡ Oz. gold § Oz. silver ; ‖ At par ; s six weeks to July 31 ; t six weeks to Aug. 15.

Miscellaneous Gold and Silver Outputs.

	July		August	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	480p§	—	440p
Colombian Mining (C'lbia)	4,416	6,704	—	—
El Oro (Mexico)	35,190	183,621†	35,020	177,148†
Esperanza (Mexico)	—	3,843e	—	3,845e
Frontino & Bolivia (C'lbia)	1,980	8,092	2,030	8,476
Keeley Silver (Canada) ..	—	67,750s	—	80,285s
Mexico El Oro (Mexico)..	13,313	249,470†	13,380	[illegible]†
Mining Corp. of Canada .	7,304	129,717	—	—
New North-West (Yukon)	—	—	—	[illegible]†j
Oriental Cons. (Korea) ...	—	75,000†	—	75,000†
Ouro Preto (Brazil)	7,500	2,944	7,600	2,687
Plym'th Cons. (Calif'rnia	8,000	8,979*	7,400	7,510*
St. John del Rey (Brazil).	—	39,500*	—	38,500*
Santa Gertrudis (Mexico)	40,510	52,824e	44,202	33,295e
Tomboy (Colorado)	15,000	61,000†	17,000	76,000†

* At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. p Oz. platinum and gold. s Oz. silver. e Profit in dollars. § Eight weeks to August 12. j July and August.

Nechi (Colombia): 27 days to September 3, $20,954 from 148,062 cu. yd.

Pato (Colombia): 41 days to August 30, $42,590 from 136,336 cu. yd.

Gold Outputs, Kolar District, India.
During August, 1922.

	Tons Ore	Oz.	Tons Tailing	Oz.	Total Oz.
Balaghat	3,800	1,922	8,000	605	2,721
Champion Reef .	12,355	3,143	23,478	1,095	4,238
Mysore	18,420	6,122	52,722	4,380	8,504
North Anantapur.	—	1,756*	700	36	1,824
Nundydroog	9,700	4,507	6,600	680	5,189
Ooregum	13,000	7,603	13,600	896	8,504

Total Gold Output for all India: February, 34,690 oz.; March, 35,607 oz.; April, 35,583 oz.; May, 36,120 oz; June, 35,860 oz.; July, 35,670 oz.

* Mill clean up.

Base Metal Outputs.

		July	August
British Broken Hill....	Tons lead carb. ore.	200	600*
	Tons lead conc.	1,130	3,870*
	Tons zinc conc.	1,080	3,365*
Broken Hill Prop.......	Tons lead conc. ...	1,837	1,867
	Tons zinc conc.	5,738	6,209
Broken Hill South	Tons lead conc.	6,622†	4,469
Burma Corporation....	Tons refined lead ..	3,405	3,421
	Oz. refined silver ..	361,514	368,704
Electrolytic Zinc	Tons zinc............	1,965	1,943
Fremantle Trading ...	Tons lead............	400	449
Mount Lyell	Tons copper	450	328
	Oz. silver	9,086	6,618
	Oz. gold	118	95
Mount Morgan	Tons copper	460	441
	Oz. gold	4,122	4,811
North Broken Hill.....	Tons lead conc......	1,750	1,720
	Tons zinc conc......	1,720	1,790
Poderosa.............	Tons copper ore	550	585
Rhodesia Broken Hill	Tons lead	1,873	1,805
San Francisco Mexico	Tons lead conc.	1,520	1,270
	Tons shipping ore ..	—	—
Sulphide Corporation ..	Tons lead conc. ...	2,670	2,350
	Tons zinc conc	3,822	3,588
Union Minière	Tons copper	4,061	3,871
Transvaal Silver	Tons silver-lead bullion	321	402
Zinc Corporation	Tons zinc conc......	8,995	9,410
	Tons lead conc. ...	767	776

* Six weeks to September 9. † Six weeks to August 12.

Imports of Ores, Metals, etc., into United Kingdom.

		July	August
Iron Ore	Tons	287,213	295,360
Manganese Ore	Tons	27,415	29,644
Iron and Steel	Tons	55,893	80,113
Copper and Iron Pyrites	Tons	35,961	25,216
Copper Ore, Matte, and Prec.	Tons	1,537	4,199
Copper Metal	Tons	5,226	7,757
Tin Concentrate	Tons	1,944	3,554
Tin Metal..	Tons	3,217	1,495
Lead, Pig and Sheet	Tons	15,059	14,645
Zinc (Spelter)	Tons	6,983	8,944
Zinc Sheets, etc................	Tons	847	1,069
Quicksilver	Lb.	93,740	61,290
Zinc Oxide....................	Tons	465	502
White Lead	Cwt.	12,405	8,496
Red and Orange Lead	Cwt.	1,944	2,206
Barytes, ground	Cwt.	40,218	70,909
Asbestos	Tons	1,122	1,874
Boron Minerals	Tons	3,997	1,242
Borax	Cwt.	3,299	7,399
Basic Slag	Tons	19,117	8,726
Phosphate of Lime..............	Tons	32,944	17,569
Mica..........................	Tons	91	124
Sulphur	Tons	2,719	3,615
Nitrate of Soda................	Cwt.	42,464	128,681
Potash Salts	Cwt.	136,244	211,395
Petroleum: Crude	Gallons	27,035,098	17,927,480
Lamp Oil	Gallons	16,586,107	5,003,698
Motor Spirit	Gallons	26,944,979	29,107,464
Lubricating Oil	Gallons	7,270,568	4,939,937
Gas Oil	Gallons	3,536,220	5,527,994
Fuel Oil	Gallons	39,478,912	52,477,736
Asphalt and Bitumen...........	Tons	23,70[illegible]	11,863
Paraffin Wax	Cwt.	192,4[illegible]	92,508
Turpentine	Cwt.	49,9[illegible]	34,385

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	June	July	August
Nigeria :	Tons	Tons	Tons
Bisichi	32	34	40
Ex-Lands	30	30	30
Filani	1½	1½	2¾
Gold Coast Consolidated	—	—	—
Gurum River	8	7	8
Jos	10½	11½	12¼
Kaduna	3	3½	3¼
Kaduna Prospectors	5	6½	3½
Keffi Consolidated	20	20	20
Lower Bisichi	6½	9¼	10½
Mongu	25	30	30
Naraguta	50	50	50
Naraguta Extended	15	26	27
Nigerian Consolidated	8½	9	9
N.N. Bauchi	56	60	60
Rayfield	50	40	40
Ropp	163	111	102
Rukuba	2	2	2½
South Bukeru	12	5	5
Tin Fields	6	8	8
Yarde Kerri	5	3	3
Federated Malay States :			
Chenderiang	74*	—	—
Gopeng	62½	68½	53½
Idris Hydraulic	19	20¾	17¼
Ipoh	18¾	18½	16
Kamunting	86*	—	—
Kinta	34¼	32¾	30
Lahat	34¾	34	32¾
Malayan Tin	80¼	92¾	86¾
Pahang	215	200	205
Pengkalen	—	—	12
Rambutan	19½	21	18
Sungei Besi	42	50	54
Tekka	31	36	31
Tekka-Taiping	15	12½	9½
Tronoh	74	78¾	71
Other Countries :			
Aramayo Mines (Bolivia)	219	225	200
Berenguela (Bolivia)	34	41	36
Briseis (Tasmania)	—	—	—
Deebook Ronpibon (Siam)	21	21	30
Leeuwpoort (Transvaal)	40*	—	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	—	35½	68
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	116¼	125	90½
Tongkah Harbour (Siam)	115	93	83
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note.—These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	667	678	613	547	438	473
February	646	668	623	477	370	412
March	655	707	606	505	445	456
April	555	584	546	467	394	434
May	509	525	483	383	337	485
June	473	492	484	435	423	509
July	479	545	481	484	494	467
August	551	571	616	447	477	467
September	538	520	561	528	595	—
October	578	491	625	628	546	—
November	621	472	536	544	564	—
December	655	518	511	577	555	—
Total	6,927	6,771	6,685	6,022	5,618	3,703

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,030	3,765	4,265	3,298	3,143
February	3,197	2,734	3,014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	2,909
July	3,373	3,756	2,824	2,734	3,086
August	3,259	2,956	2,786	3,051	3,001
September	3,157	3,161	2,734	2,338	—
October	2,870	3,221	2,837	3,161	—
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	23,550

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	July 31	Aug. 31	Sept. 30
Straits and Australian Spot	2,361	2,694	2,714
Ditto, Landing and in Transit	475	225	25
Other Standard, Spot and Landing	4,254	4,195	4,383
Straits, Afloat	650	1,025	455
Australian, Afloat	75	75	125
Banca, in Holland	2,700	2,624	2,573
Ditto, Afloat	459	735	891
Billiton, Spot	27	27	14
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	610	650	450
Total Afloat for United States	5,137	6,697	7,622
Stock in America	2,616	2,806	1,236
Total	20,364	21,753	20,488

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	July	Aug.	Sept.
Shipments from :			
Straits to U.K.	720	1,060	250
Straits to America	2,890	4,160	3,350
Straits to Continent	425	635	450
Straits to other places	150	125	250
Australia to U.K.	50	25	150
U.K. to America	490	50	75
Imports of Bolivian Tin into Europe	202	1,640	1,394
Supply :			
Straits	4,035	4,035	4,050
Australian	50	50	150
Billiton	—	—	—
Banca	846	846	1,760
Standard	684	684	928
Total	5,615	5,615	6,888
Consumption :			
U.K. Deliveries	2,420	2,420	1,770
Dutch ,,	313	313	548
American ,,	4,590	4,590	5,050
Straits, Banca & Billiton, Continental Ports, etc.	486	486	785
Total	7,809	7,809	8,153

Imports and Exports of Gold and Silver

During August, 1922.

		Imports.	Exports.
Gold :	Unrefined Bullion.... £	508,496	—
	Refined Bars........ ,,	3,424,542	2,553,250
	Coin .... ,,	4,176	233,779
Silver :	Unrefined Bullion ... oz.	391,324	—
	Refined Bars........ ,,	2,816,505	5,662,195
	Coin .... £	604,162	190

Outputs Reported by Oil-producing Companies.
In Tons.

	June.	July	August
Anglo-Egyptian	17,893	8,607	19,195
Anglo-Texas	1,994	1,994	1,784
Anglo-United	—	—	—
Apex Trinidad	5,000	7,300	11,900
Astra Romana	32,800	32,542	33,210
British Burmah	10,084	10,2?2	9,989
Caltex	10,348	—	10,484
Dacia Romana	553	786	1,107
Indo-Burma	—	—	—
Kern River	12,339	13,394	13,372
Lobitos	8,697	8,845	9,371
Phœnix	6,289	5,830	3,250
Romana Americana	26,300	18,145	16,890
Roumanian Consolidated	1,814	—	1,504
Santa Maria	1,415	1,471	1,543
Steaua Romana	18,427	19,170	20,680
Trinidad Leaseholds	8,500	8,600	9,500
United of Trinidad	3,924	4,683	5,376

Quotations of Oil Companies' Shares.
Denomination of Shares £1 unless otherwise noted.

	Sept. 6, 1922 £	s.	d.	Oct. 5, 1922 £	s.	d.
Anglo-American	4	19	0	5	0	0
Anglo-Egyptian B	1	10	0	1	11	0
Anglo-Persian 1st Pref.	1	6	0	1	4	9
Apex Trinidad	2	3	9	2	2	6
British Borneo (10s.)		13	9		11	3
British Burmah (8s.)		11	3		11	3
Burmah Oil	5	17	6	5	12	6
Caltex ($1)		1	6		1	3
Dacia Romano		15	0		15	0
Kern River, Cal. (10s.)	1	2	0	1	0	0
Lobitos, Peru	5	16	3	5	15	0
Mexican Eagle, Ord. ($5)	3	8	9	2	17	6
,, ,, Pref. ($5)	3	5	0	2	13	9
North Caucasian (10s.)		15	0		15	0
Phœnix, Roumania	1	9	0	1	6	0
Roumanian Consolidated		15	9		3	9
Royal Dutch (100 gulden)	39	10	0	39	10	0
Scottish American		2	0		1	6
Shell Transport, Ord.	4	12	6	4	10	0
,, ,, Pref. (£10)	9	15	0	9	10	0
Trinidad Central	2	0	0	1	18	9
Trinidad Leaseholds	1	6	3	1	5	0
United British of Trinidad		10	0		8	9
Ural Caspian		13	9		15	0
Uroz Oilfields (10s.)		10	0		9	6

Petroleum Products Prices. October 6.

Refined Petroleum: Water white, 1s. per gallon; standard white, 11d. per gallon; in barrels 3d. per gallon extra.

Motor Spirit: In bulk: Aviation spirit, 2s. 1d. per gallon; No. 1, 1s. 9d. per gallon; No. 2, 1s. 7d. per gallon.

Fuel Oil: Furnace fuel oil, £3 5s.: Diesel oil, £4 2s. 6d. per ton.

American Oils: Best Pennsylvania crude at wells, $3·00 per barrel. Refined standard white for export in bulk, 6·5 cents per U.S. gallon; in barrels 12·5 cents. Refined water white for export in bulk, 7·5 cents per U.S. gallon; in barrels 13·5 cents.

Dividends Declared by Mining Companies
During month ended October 10.

Company	Par Value of Shares	Amount of Dividend
Amalgamated Zinc	£1	1s. less tax.
Arizona Copper	5s.	1s. tax paid.
British Aluminium	Pref. £1	3% less tax.
	Ord. £1	2½% less tax.
Shamva Mines	£1	6¼% less tax.
Gopeng	£1	9d. less tax.
Electrolytic Zinc	Pref. £1	7·4d.
Kinta Tin	£1	2½% less tax.
Siamese Tin	£1	5% less tax.
New Jagersfontein	£1	2s. 6d.
Kern River Oilfields	10s.	10% less tax.
North Broken Hill	£1	1s. less tax.
Ooregum Gold	Pref. 10s.	1s. 9d. less tax.
	Ord. 10s.	9d. less tax.
Gaika Gold	£1	7½% less tax.
Rio Tinto	£5	10s. less tax.

PRICES OF CHEMICALS October 6.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	0
,, 80%	,,	2	0	0
,, Glacial	per ton	65	0	0
Alum	,,	14	0	0
Alumina, Sulphate	,,	11	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	25	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	35	0	0
,, ,, pure	per cwt.	3	5	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	70	0	0
,, Sulphate	,,	16	0	0
Antimony, Tartar Emetic	per lb.		1	7
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	44	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			7
,, Chloride	per ton	22	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		2	0
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	13	0	0
,, Liquor, 7%	,,	4	10	0
Borax	,,	29	0	0
Boric Acid Crystals	,,	60	0	0
Calcium Chloride	,,	7	0	0
Carbolic Acid, crude 60%	per gal.		2	0
,, ,, crystallized, 40°	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		2	2
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100%	per lb.			10½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	8	10	0
,, Sulphate	,,	2	10	0
Lead, Acetate, white	,,	40	0	0
,, Nitrate	,,	44	0	0
,, Oxide, Litharge	,,	39	0	0
,, White	,,	42	0	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey 80%	,,	14	10	0
Magnesite, Calcined	,,	12	0	0
Magnesium, Chloride	,,	8	0	0
,, Sulphate	,,	8	0	0
Methylated Spirit 64° Industrial	per gal.		2	8
Nitric Acid, 80° Tw.	per ton	26	0	0
Oxalic Acid	per lb.			8
Phosphoric Acid	per ton	32	0	0
Potassium Bichromate	per lb.			6½
,, Carbonate	per ton	28	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	11	0	0
,, Hydrate (Caustic) 90%	,,	29	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			8
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	3
,, Sulphate, 90%	per ton	15	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate 45%	,,	34	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			6
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			3½
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	11	0	0
,, Nitrate, 96%	,,	14	0	0
,, Phosphate	,,	15	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	15	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salts)	,,	4	10	0
,, Sulphide	,,	22	0	0
,, Sulphite	,,	10	0	0
Sulphur, Roll	,,	9	0	0
,, Flowers	,,	8	10	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 30%	,,	4	0	0
Tartaric Acid	per lb.		1	4
Turpentine	per cwt.	5	3	3
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	0
Zinc Chloride	per ton	20	0	0
Zinc Oxide	,,	42	0	0
Zinc Sulphate	,,	13	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Oct. 6, 1921 £	s.	d.	Oct. 5, 1922 £	s.	d.
RAND:						
Anglo-American Corporation	1	0	0	1	5	0
Brakpan	2	15	0	2	18	9
Central Mining (£8)	6	15	0	9	2	6
City & Suburban (£4)		2	9		2	9
City Deep	2	8	9	2	13	9
Consolidated Gold Fields		18	9		18	9
Consolidated Langlaagte		15	0		17	6
Consolidated Main Reef		10	0		12	6
Consolidated Mines Selection (10s.)		15	0		18	9
Crown Mines (10s.)	2	0	0	2	17	6
Daggafontein		2	9		3	9
Durban Roodepoort Deep		5	6		13	6
East Rand Proprietary		5	3		12	0
Ferreira Deep		9	6		10	0
Geduld	2	5	0	3	7	6
Geldenhuis Deep		5	6		7	6
Government Gold Mining Areas	4	0	0	5	7	6
Johannesburg Consolidated	1	3	0	1	9	6
Kleinfontein		6	0		9	3
Knight Central		4	6		4	3
Langlaagte Estate		12	9	1	3	0
Luipaards Vlei		3	9		4	0
Meyer & Charlton	4	0	0	3	17	6
Modderfontein, New (10s.)	3	15	0	4	6	3
Modderfontein B (5s.)	1	6	3	1	13	9
Modderfontein Deep (5s.)	2	5	0	2	7	6
Modderfontein East		10	6		9	9
New State Areas	1	3	9	1	15	0
Nourse		9	6		17	6
Rand Mines (5s.)	2	6	3	3	2	6
Randfontein Central		11	0		17	0
Robinson (£5)		9	6		10	0
Robinson Deep A (1s.)		10	0	1	13	9
Rose Deep		13	3		16	0
Simmer & Jack		2	9		4	0
Springs	2	2	6	2	12	6
Sub-Nigel		12	6		12	3
Union Corporation (12s. 6d.)		14	6	1	0	6
Van Ryn		11	9		13	6
Van Ryn Deep	3	15	0	3	13	9
Village Deep		8	3		16	6
West Springs		11	3		14	9
Witwatersrand (Knight's)		12	6		17	6
Witwatersrand Deep		7	6	1	2	6
Wolhuter		4	3		4	0
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		7	6		13	9
Transvaal Gold Mining Estates		8	6		11	3
DIAMONDS IN SOUTH AFRICA:						
Consolidated of S.W.A.		—		1	1	0
De Beers Deferred (£2 10s.)	11	0	0	13	0	0
Jagersfontein	2	7	6	3	12	6
Premier Deferred (2s. 6d.)	5	15	0	6	0	0
RHODESIA:						
Cam & Motor		9	6		18	3
Chartered British South Africa		11	0		13	3
Falcon		5	0		5	9
Gaika		9	6		12	0
Globe & Phœnix (5s.)		13	6		12	0
Gold Fields Rhodesian (10s.)		5	6		6	6
Lonely Reef	2	7	6	2	2	6
Rezende	3	10	0	3	2	6
Shamva	1	11	3	1	10	0
WEST AFRICA:						
Abbontiakoon (10s.)		3	0		2	3
Abosso		8	9		7	6
Ashanti (4s.)		15	6		14	3
Prestea Block A		2	9		1	3
Taquah		8	6		6	6
WEST AUSTRALIA:						
Associated Gold Mines		2	3		6	9
Associated Northern Blocks		2	3		2	3
Bullfinch (5s.)		1	0		1	0
Golden Horse Shoe (£5)		11	3		13	9
Great Boulder Proprietary (2s.)		5	6		4	9
Great Fingall (10s.)		1	6		1	0
Hampton Celebration		3	0		2	6
Hampton Properties		5	0		6	6
Ivanhoe (£5)		18	9		17	6
Lake View Investment (10s.)		8	9		10	6
Lake View and Star (4s.)		2	3		1	3
Oroya Links (5s.)		1	3		1	0
Sons of Gwalia		3	9		2	0
South Kalgurli (10s.)		[illegible]	6		7	9

GOLD, SILVER, cont.	Oct. 6, 1921 £	s.	d.	Oct. 5, 1922 £	s.	d.
NEW ZEALAND:						
Blackwater		2	6		6	3
Waihi	1	2	6	1	7	6
Waihi Grand Junction		8	9		8	9
AMERICA:						
British Platinum, Colombia		10	0		12	0
Camp Bird, Colorado		4	3		4	6
El Oro, Mexico		9	6		9	6
Esperanza, Mexico		17	6		11	6
Frontino & Bolivia, Colombia		6	3		10	0
Kirkland Lake, Ontario		10	0		12	0
Le Roi No. 2 (£5), British Columbia		2	6		1	6
Mexican Corporation, Mexico		—			7	6
Mexico Mines of El Oro, Mexico	4	7	6	5	13	9
Nechi (Pref. 10s.), Colombia		4	6		5	6
Oroville Dredging, Colombia	1	2	6	1	2	6
Ouro Preto, Brazil		16	3		14	6
Plymouth Consolidated, California		10	0		7	6
St. John del Rey, Brazil		16	0		18	9
Santa Gertrudis, Mexico		7	6		7	9
Tomboy, Colorado		5	0		9	6
RUSSIA:						
Lena Goldfields		7	6		8	9
Orsk Priority		5	0		5	0
INDIA:						
Balaghat (10s.)		8	0		7	6
Champion Reef (2s. 6d.)			6		6	6
Mysore (10s.)		12	3		12	9
North Anantapur		5	0		2	6
Nundydroog (10s.)		6	9		7	3
Ooregum (10s.)		13	0		15	0

COPPER:	£	s.	d.	£	s.	d.
Arizona Copper (5s.), Arizona		17	6		16	3
Cape Copper (£2), Cape and India		12	6		10	0
Hampden Cloncurry, Queensland		6	3		5	0
Mason & Barry, Portugal	2	0	0	2	5	0
Messina (5s.), Transvaal		3	6		3	0
Mount Elliott (£5), Queensland		11	3		12	6
Mount Lyell, Tasmania		12	6	1	0	6
Mount Morgan, Queensland		12	6		11	3
Namaqua (£2), Cape Province		15	0	1	15	0
Rio Tinto (£5), Spain	28	10	0	28	10	0
Russo-Asiatic Consd., Russia		7	6		10	6
Sissert, Russia		5	0		4	6
Spassky, Russia		8	9		11	3
Tanganyika, Congo and Rhodesia	1	0	0		16	0

LEAD-ZINC:	£	s.	d.	£	s.	d.
BROKEN HILL:						
Amalgamated Zinc		16	3		17	6
British Broken Hill		18	9	1	7	6
Broken Hill Proprietary	1	13	9	1	7	6
Broken Hill Block 10 (£10)		10	0		5	0
Broken Hill North	1	8	9	2	0	0
Broken Hill South	1	5	0	2	0	0
Electrolytic Zinc Pref.		—		1	5	0
Sulphide Corporation (15s.)		11	0		12	6
Zinc Corporation (10s.)		17	6		12	0
ASIA:						
Burma Corporation (10 rupees)		6	0		6	6
RHODESIA:						
Rhodesia Broken Hill (5s.)		5	6		6	6

TIN:	£	s.	d.	£	s.	d.
Aramayo Mines, Bolivia	1	12	6	2	5	0
Bisichi (10s.), Nigeria		5	0		5	3
Briseis, Tasmania		2	6		3	6
Chenderiang, Malay		10	0		5	0
Dolcoath, Cornwall			9		1	6
East Pool (5s.), Cornwall		3	0		2	6
Ex-Lands Nigeria (2s.), Nigeria		1	3		1	6
Geevor (10s.), Cornwall		2	6		3	9
Gopeng, Malay	1	12	6	1	13	9
Ipoh Dredging, Malay		10	0		8	9
Kamunting, Malay	1	3	9		18	9
Kinta, Malay	1	12	6	1	12	6
Lahat, Malay		10	0		6	3
Malayan Tin Dredging, Malay	1	1	3	1	3	9
Mongu (10s.), Nigeria		10	0		8	9
Naraguta, Nigeria		12	6		12	6
N. N. Bauchi, Nigeria (10s.)		2	0		2	0
Pahang Consolidated (5s.), Malay		5	6		4	9
Rayfield, Nigeria		2	6		2	0
Renong Dredging, Siam	1	3	9		18	9
Ropp (4s.), Nigeria		6	0		5	9
Siamese Tin, Siam	1	17	6	1	12	6
South Crofty (5s.), Cornwall		3	6		5	0
Tehidy Minerals, Cornwall		5	0		7	6
Tekka, Malay		17	6		18	9
Tekka-Taiping, Malay	1	0	0		17	6
Tronoh, Malay	1	5	0	1	10	0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

LEAD AND ZINC MINING IN THE LAKE DISTRICT

We continue our précis of Mr. Eastwood's Memoir prepared for the Geological Survey on the lead and zinc ores of the English Lake District.

Threlkeld.—This mine is situated ½ mile N.N.E. of Threlkeld village and east of Keswick. The two veins at this property have been worked as separate undertakings. Gategill is believed to have been wrought in pre-gunpowder days. Woodend is somewhat younger. It was reopened between 70 or 80 years ago by Walton and Cowper, and continued working on a small scale until 1863. After an interval of 13 years, Gategill and Woodend were taken up by the Saddleback Mining Co., and some galena raised, chiefly from Gategill. Three years later the holdings were transferred to the Threlkeld Mining Co., which really developed the undertaking. The company went into liquidation in 1913 owing to the ore in depth proving to occur in short sops separated by much barren ground. It has recently been taken up by Threlkeld Mines, Ltd., under the direction of Anthony Wilson.

In the southern portion of the field there are two veins, about 200 yd. apart, ranging N.N.W. and S.S.E., which were worked independently in the past, the south-western vein and mine being known as Woodend and the one to the north-east as Gategill. When the workings on the Woodend vein had been pushed farther north, it was found that the vein had gradually swung round to about 10° E. of N., while the Gategill vein had retained its original direction and at the intersection of the two was displaced about 20 fm. Unfortunately, detailed plans and reliable cross-sections are not available, but, according to information given personally by J. Postlethwaite, the intersection takes place above and just beyond the new shaft, situated about 370 fm. along the Woodend horse level.

The mining ground at Threlkeld rises by a series of steep slopes and crags from 700 ft., at the mouth of the mine, to 2,800 ft. on Hallsfell Top (the western end of Saddleback) in a distance of about 1 mile. The country—Skiddaw Slates—is traversed by numerous quartz strings, and as the veins make practically no show at the surface it is impossible to trace them without trial excavations. A group of narrow greenstone dykes crop out in Gategill, but cause no marked alteration in the shales beyond a slight hardening. According to J. Postlethwaite a mass of igneous rock, hading northward at 5 ft. per fm., was cut through in the Woodend high level (Smithy level). It there measured 40 fm. in width, while in the deeper levels it was somewhat thinner and divided by 10 fm. of Skiddaw Slate. The veins were highly productive when in contact with the igneous rock. Unfortunately, no record of these occurrences has been kept at the mine. The present underground manager, Mr. Hewitson, states that some time ago a hard speckled rock, 2 ft. in thickness and inclined from the vertical, crossed the vein in one of the stopes. This may be another greenstone. He doubts whether the lode was affected, but states that blende continued up to the mass on one side but not beyond. Some chiastolite slate has been met with in the workings, but here, again, the exact location and effect upon the lode is doubtful. The Woodend vein, contrary to the general rule, hades westward at from 40° or 30° from the vertical to nearly perpendicular, though the average is about 20°. The mean breadth of the vein may be taken as 4 or 5 ft., some stopes attaining 9 and 10 ft. in width while others are less than 3 ft. The hanging-wall, though usually well defined, is apt to prove a false guide in the nips, or in barren ground, and leads off to the west, especially when, as frequently happens, stringers are given off on this side. The foot-wall is usually better defined and safer to follow. The vein contains much country rock, especially when poor, but when the lode is rich there is usually a considerable amount of quartz (one-third to one-half the vein) in the form of soft sugary sand. In the deeper parts of the mine, now abandoned, pyrites was somewhat abundant and a Varpart disintegrator was in use to separate it from the other ores. That occurring above the horse level is usually in a fine state of division; it is found mostly in the deads, and causes trouble, not so much in the dressing as by rotting the iron ventilation pipes, etc. Except in the case of one of the stringers barytes does not occur in this mine. Galena occurs in strings and ribs generally from 2 to 6 in., though occasionally 1 ft., in thickness. Blende, often found in strings, is usually more irregular, occurring in scattered bunches and splotches or disseminated through the gangue; the average proportion in the present workings is about one of blende to three of galena, although in some stopes blende is predominant. Occasionally both ores occur in a fine state of division in sugary quartz; blende is then irrecoverable and floats off in dressing. There is a little copper pyrites of no commercial value. The silver content of the pig lead is generally about 8 oz. to the ton.

The ore-bodies slope downward to the north and are richest where the vein is wide and crossed by quartz strings. In depth—below the horse level down to 30 fm.—the ore-bodies were small (5 or 10 fm. in length, separated by 100 fm. of barren ground) and pyrites gave trouble. When the mine came into the hands of the liquidator the northern limit of the stoping-ground was regarded as a fault, but finding some indication of a foot-wall, the present holders continued driving and discovered a considerable ore-body at a point about a mile along the horse level. Here the galena and blende occurs in broad irregular bands, up to 1 ft. or 18 in. thick, in soft sugary quartz interlacing the deads. A trial stope, 60 ft. above the horse level, looks promising, and it is said that the ore-body is improving in height.

Branches are given off in places from the Woodend vein. One of these is visible about 1,000 yd. along the horse level on the hanging side. It was stoped

to a small extent. About half a mile along the horse level, near the site of the electric hoist, a short cross-cut east was made to endeavour to locate the Gategill vein. A small vein was cut, believed to be a stringer from the Woodend lode; it carried barytes and little sops of blende but was poor in galena. The barytes is of good quality, white and practically free from metallic ores, but is not in sufficient quantity to work.

Little information is available concerning Gategill vein, which is reported to have been mainly a galena vein with but little blende. The hade is said to be similar to that of Woodend, but where seen in Gategill is slightly east of vertical. The point of intersection with the Woodend vein was the richest part of the mine.

The main operations have been in the Woodend vein, and the horse level, beginning at 700 ft. O.D., at the foot of Gategill, is driven along the somewhat winding course of the vein for about a mile. Halfway along its course a blind shaft led down to the 20 and 30 fm. levels, also reached by a shaft outside the main entrance. Both these shafts are now filled up. There are older levels farther up stream; of these, Smithy or Woodend high level begins as a short cross-cut, at about 820 ft. O.D. Higher up the ravine is the Woodend top level cross-cut, commenced about 1870 and believed to be 160 fm. in length to the Woodend vein. Close by, at 1,020 ft. O.D., is the Gategill bottom level, collapsed at the entrance, where the lode, 3 ft. wide and with a western wall of greenstone, is seen coursing N. 30° W. About 200 yd. farther N.N.W. is the site of the Gategill top level, which begins with a cross-cut of 10 fm. and is then driven 60 fm. on the lode (Gategill). The middle level is not visible; but both veins are said to have been wrought from it. These levels extend almost as far north as the horse level and are probably all on the Woodend vein in the hill, though the upper ones commence on the Gategill vein to the south of the point of intersection. Haulage in the mine is by horses and mules along the horse level. Material is shot on to the picking-grates, where the block galena and the deads are removed. The residue is raked into tubs below and tipped to the crushing-plant. After sizing, it is dealt with in five sets of four-compartment jigs, and a Huntington mill grinds the rejects. The fines are treated on two modified Wilfleys and two Luhrig vanners. Two dollies have replaced the buddles at one time in use here. The slime-treatment plant is admittedly defective and is to be improved. Settling areas similar to those at Thornthwaite are in process of construction. Water for dressing comes from Gategill Beck, the plant being operated by a gas-engine. Transport is by cart to Threlkeld Station (C.K. & P. Railway), a distance of a little over 1 mile.

As the newer part of the mine is only in the developmental stage, the output is at present small. In the past about 100 men and boys were employed, with an average yearly production of 550 tons of galena and 700 tons of blende.

The output of Woodend mine in 1848 was 36 tons of dressed lead ore. For the next two years figures are not given. From 1851 to 1853 the figures are 13, 8½, and 30 tons respectively. After another interval, 58 tons was produced in 1862 and 23 in 1863.

[The latest information about operations at Threlkeld were given by our Cumberland correspondent in the September issue.—EDITOR.]

Force Crag.—This mine is situated at the head of Coledale, 2½ miles south-west of Braithwaite village, west of Keswick. The mine has a somewhat chequered history partly attributable to the difficulties in the past of separating blende from barytes, and the predominance of those two minerals over the more readily dressed lead ore. About the year 1830 the mine was opened, or probably reopened, by Mr. Walton, of Alston, Dowthwaite and Cowper, of Keswick, and others, who drove Nos. 1, 2, and 3 levels. A considerable amount of ground was excavated, especially in the old stope, where the most productive ore-body lay. As barytes was unsaleable in those days, little attention was paid to it.

After a short interval, the mine was reopened for barytes, and as that mineral was found to be more plentiful on the higher ground, the lower levels were abandoned and the Nos. 4 and 5 levels commenced. A tramway was constructed to the village and mills erected, but the undertaking proved unremunerative and the mine was abandoned in 1880. In 1906 the mine was taken up for lead and zinc ores by Dennison, Meakin, and Lobb, who reopened the lower levels and installed a Pelton wheel and dressing-plant. Owing to the difficulties of dressing blende and barytes the mine was abandoned in 1909. The Coledale Mining Syndicate began in 1912, and lasted until 1915. They were responsible for the erection of Elmore plant, but were hampered by inadequate crushing machinery. The present company, Braithwaite Mines, Ltd., was formed about the year 1916.

The Force Crag vein is believed to extend from the head of Coledale westward to the foot of Crummock Water, a distance of nearly 3 miles; but with the exception of a small trial near Lanthwaite Gate, at the western end, it has been worked only at Force Crag. A parallel vein (Long Crag) crops out some 200 yd. north of Force Crag vein, but it has not been worked, and there is little or no information concerning it. The Force Crag vein courses a little N. of E. and S. of W. through the Skiddaw Slate Series, and generally hades northward at 75° from the horizontal, though at times it is practically vertical. The vein-filling, apart from minerals of economic importance (blende, galena, and barytes), consists mainly of brecciated rock, with thin irregular strings of quartz. Of the other minerals, psilomelane occurs in the higher part of the vein, and a little dolomite is of general distribution, along with some chalybite and pyrites. Cerussite and stolzite (tungstate of lead) are also reported, and during Mr. Eastwood's visit, a few small crystals of pale greenish fluorspar were obtained for the first time. The order of introduction of the minerals is not always obvious, as quartz has been introduced into the vein at several times, but with this exception the general rule appears to be an initial deposition of quartz, followed in turn by galena, blende, barytes-dolomite, and psilomelane-pyrites. The paired minerals appear to be interchangeable. The proportion of barytes to ores is about 3 : 1, and, of the ores, blende is about 10 times as common as galena. The average silver content of the lead is about 30 oz., though sometimes it is as high as 35 oz. per ton.

The width of the vein, which varies from 1 to 20 ft., probably averages 5 ft., and the walls are usually well defined. In places, as in the middle portion of No. 1 level, the lode splits into two

veins, from 2 to 4 ft. wide, separated by a barren tract or horse 12 to 15 ft. across. Small branches or veinlets are given off at different points. These usually carry ore near the vein only. On the top of the mountain the vein consists mainly of barytes with psilomelane, lead and zinc being practically absent. In depth, blende with some galena becomes more abundant, in No. 3 level, and the stopes above it, for example, where they form the chief ores, the barytes here occurring in small patches on the walls and occasionally running irregularly through the vein. In No. 1 level—the lowest worked—barytes comes on again. In a stope just east of the cross-cut to the level the vein is 15 to 20 ft. wide and has lenses of good white barytes on the walls, 2 to 3 yd. long and 6 to 8 in. thick, in addition to ribs in the middle of the vein. Where the horse appears the veins carry in places 6 in. to 3 ft. of solid barytes. Blende, though sometimes in ribs and in bunches, is more often somewhat scattered. Galena is usually in bunches, is frequently scattered, and but seldom occurs in solid ribs. The lead and zinc ores are usually in bands running diagonally through the veinstuff from N.E. to S.W. Sometimes these runs of ore appear to be in conjunction with slips, but this is not always the case.

The vein has been opened up by a system of levels, the highest (No. 5) being about 400 ft. above No. 1. Extensive screes (talus) on the lower slopes of the hill have necessitated the use of cross-cuts, driven from the south, from which the three bottom levels (Nos. 1, 2, and 3) proceed. No. 1 cross-cut is about 120 yd. long, the others one-half and one-third that distance. No. 3 level is 15 fm. above No. 2, and the latter 24 fm. above No. 1. Nos. 4 and 5 levels, opened directly on the vein, are now disused, but may be reopened for the purpose of winning barytes. No. 1 level has been driven west about 180 fm., but the vein there is said to be disturbed and may be faulted. From No. 1 level two cross-cuts have been driven northwards towards Long Crag vein (believed to crop out about 200 yd. north of the Force Crag lode), but were abandoned before attaining half the distance. A cross-cut, commenced some years ago with the object of cutting the Force Crag vein 120 ft. below No. 1 level, has not been completed, and mining is confined to the ground between No. 1 and No. 3 levels. No. 1 level and cross-cut form the main drain of the mine, and no pumps are required. Up to the present, mining has been done by hand labour, but a compressor has been installed recently and rock-drills will be used in future. Some of the lump barytes is picked out in the mine, while the rest of the material is trammed from No. 1 level to the picking-grate above a Marsden stone-breaker. After breaking, the ore is first subjected to the ordinary processes of classifying and jigging. The rejects from the jigs are ground in a ball-mill and are then ready for the four Deister tables, two of which are for sands and two for fines. The mixture of blende and barytes from the tables is treated by the Elmore flotation process, which gives practically pure blende. The gangue from the Elmore process is then cleaned upon a long Buss table and yields a medium-grade barytes sand. Power is supplied by a Pelton wheel using water from a reservoir at the head of the beck, 600 ft. above the level of the mine buildings. Transport is by cart to Braithwaite station (C.K. & P. Ry.), a distance of 3 miles by a well-graded road. Some years ago a tramway was constructed, but the metals were subsequently removed.

The output of dressed lead ore for 1848-49-50 was 43, 27, and 8 tons respectively. From 1857 to 1863 a total of 295½ tons was produced, while, in 1872, 600 tons of blende was sold. Ten tons of dressed blende was sold in 1908; and 9 tons of galena, 140 tons of blende, and 35 tons of barytes in 1909. In 1913, galena amounting to 32 tons was obtained.

(To be concluded.)

IRON ORES OF BRITISH AFRICA

In the MAGAZINE for September attention was directed to the series of volumes on the iron-ore deposits of the British Empire and of the world issued by the Imperial Mineral Resources Bureau; a general review of these volumes was given by Professor Henry Louis, and also an outline of the reserves in the British Islands as recorded in Part I of the series. In the following paragraphs we deal with Part 2, which covers British Africa.

Union of South Africa.—Up to 1918 there was no commercial production of iron or steel from local ores, all the production being obtained by the utilization of scrap metal from the railways, mines, and other sources. Large deposits of iron ore have been found in various parts of the country, and in 1918 experimental blast-furnaces were erected near Pretoria and at Vereeniging to test some of these ores. Proposals have been made recently to erect further smelting plants at various places. The deposits of primary importance at the present time occur in the Transvaal, where the principal fields of exploitation are associated with the Pretoria series. In Natal also there are important occurrences, consisting chiefly of magnetite and hematite. The only iron ores in Cape Province known to exist in such quantities as to make them of economic interest are those associated with the Lower Griqua Town beds in Griqualand West and Bechuanaland. These beds consist of siliceous rocks containing thin layers of magnetite, coloured by limonite and hematite. In the Orange Free State no iron ores of commercial value have as yet been reported; on a map by G. W. Stowe, iron-ore occurrences are marked between the Vaal and Valsch Rivers, due south of Potchefstroom, these being probably banded ironstone of the Hospital Hill series. In the South-West Africa Territory brown calcareous ironstone is found, associated with crystalline limestone, but appears to have been chiefly worked for fluxing copper and lead ores.

Transvaal.—Frequent mention is made in the Reports of the Geological Survey of the presence of hematite, magnetite, chromite, etc., in the Transvaal Province, but no estimates have as yet been made of available resources. T. G. Trevor classifies the deposits as follows :—

(*a*) Ore associated with the Bushveld granite.
  (1) Titaniferous iron ore.
  (2) Chrome iron ore.
(*b*) Magnetite quartzites of the Pretoria Series.
(*c*) Banded hematite of the Swaziland Series.
(*d*) Other deposits.
  (1) Hematite of the Coal Measures.
  (2) Earthy deposits in Upper Dolomite.
  (3) Hematite in disturbed rocks on the edge of the Bushveld granite.

At the date of Mr. Trevor's report the possibility of production locally of good metallurgical coke was in doubt and the highly siliceous ores only were considered available, but since then much work has been done.

(*a*) (1) Beds of titaniferous iron ore are seen near Onderstepoort and elsewhere in the vicinity, and are exposed on the railway track of the Pretoria–Pietersburg railway about 2 miles south of Waterval North station, where the beds strike east and west, and dip steeply to the north. Farther to the east on the veld, near Kaffirkraal, the outcrops are practically horizontal, and are many yards in width. Immediately to the west of the railway there is not much evidence of a strong body of ore, but some 2 miles farther west, ore of similar character and occurrence to that on the east of the railway outcrops on the surface. Here some trenches have proved the ore-body to be of no great thickness. The occurrences belong to the group of deposits lining the edge of the Bushveld igneous complex from Rustenburg and Secocoeniland, a distance of some 200 miles. They are not continuous, but occur again and again on the same horizon, always having the same characteristics, and as far as is known approximately the same composition. From Waterval North station, the deposit has been traced about 6 miles to the east. Towards the outcrop, the weathered norite country rock becomes steadily poorer in felspar and richer in iron ore, until finally practically nothing is left but almost pure magnetite rock. Analyses give 62 to 68% Fe_3O_4 and 2 to 9% or more TiO_2. The beds are all well defined and can be generally estimated at not less than 4 ft. thick. For a short distance on the surface they lie almost horizontal, but then take a steeper inclination, which probably arrives at an angle of about 20 to 25° as soon as the influence of the surface is passed. A large quantity of ore could be quarried at the surface, but to maintain the output underground mining would be necessary. Mining facilities appear to be exceptionally good in this area, both the railway and Aapies River crossing the deposits within a mile of each other, and the nearest coalfield being at Waterval, 4 miles distant. Lime is to be obtained from Irene, 22 miles distant.

The occurrences at Magnet Heights, in the district of Lydenburg, are situated 53 miles by road north-west of Lydenburg on the north bank of the Steelpoort River. The country rock is the norite of the Bushveld complex, and in it at this point a number of beds of magnetite occur, from 1 in. up to 8 ft. in thickness. Near the main road over the pass five beds are exposed in section, the lowest being at least 6 ft. thick. In the neighbourhood of the iron-ore beds the magnetite has become decomposed, and over a large area denudation has worn off all the overburden and left the beds of magnetite forming the surface of the ground. The main 6 ft. bed is thus exposed over some 800 acres. The beds are conformable, dipping at an angle of from 10 to 14° in a north-westerly direction. The quantity of ore available is undoubtedly very large, and is estimated for the 6 ft. bed referred to at 24,000,000 tons, in sight on the surface. The nearest coal is at Belfast, 70 miles distant, and the nearest lime at Kalkfontein, 10 miles distant. The Steelpoort River runs at the foot of the escarpment along which the beds outcrop, and a railway could readily be constructed along the valley thereof from the main line at Wonderfontein.

Small bands of titaniferous magnetite occur in the norite of the Magalakwin Valley, the outcrops observed being near the western boundary of the norite and mainly within the native locations. The bands are probably about 6 ft. in thickness. The ore is similar to that which forms so characteristic a feature of the norite in other parts of the country, where, however, it occurs in much greater quantity.

(*a*) (2) Chrome iron ore also occurs in the norite margin of the Bushveld granite. The beds are parallel and very similar in occurrence to those described above, though they are found chiefly nearer the outer edge of the norite and farther away from the granite than the magnetite beds. They are not so extensive as the titaniferous deposits, but apparently there is a fairly large tonnage available. The deposits occur extensively in the area midway between Lydenburg and Pietersburg about 40 miles distant from each, and are readily accessible from the road joining those two places. The country rock in which they occur is not the typical norite, but belongs to the pyroxenite and hypersthenite or enstatite varieties. Trevor gives the following analysis of a sample of chromite from this locality: Chromium 29·5% equal to 43·2% chromic oxide; iron oxide 45%; silicate of alumina 10%; manganese absent.

(*b*) The magnetitic quartzites of the Pretoria Series are well developed over a large area especially in the neighbourhood of Pretoria, Potchefstroom, and Airlie. They occur in the shales of the Pretoria Series, which extends for hundreds of miles, and in the lower horizon well-defined and permanent beds of the ore are found up to 15 ft. thick, dipping very steeply and forming well-defined ridges, but the iron content varies so considerably that in many places the material cannot be called an iron ore. Trevor estimates that many hundred million tons of the ore could be obtained. The ore is everywhere siliceous, but to a variable extent. Trevor gives the iron content as 41 to 48% and Harbord 45 to 47%, with silica at 35 to 24%. The ore is oolitic in character, and the iron mineral, which is only slightly magnetic, is regarded by Stanley as martite, and not magnetite or limonite as previously assumed.

On the Pretoria Town Lands alone, many millions of tons are stated to be cheaply obtainable. The beds occur interbedded in the shales of the Timeball Hill district and adjacent ranges, within half a mile of Pretoria station, the nearest coalfield being at Waterval, 15 miles distant. Only two of the beds are of any importance, the upper one being 15 ft. in thickness and the lower one 6 ft. with 100 ft. of shale separating them. Faults are somewhat frequent and the dip varies from 20 to 60°. According to a preliminary report on a lease now forming part of the South African Iron and Steel Corporation, the property is divided into five areas, and the ore contained in the deposits is estimated at 28,800,000 tons, the average iron content of which can be placed at 45%. The reserve of clay-band ore, probably averaging 50 to 55% of iron, is 2,510,200 tons.

Trevor estimates that a practically unlimited supply of ore exists at Airlie, in the Lydenburg district. The deposits, which are situated within half a mile of Airlie station, consist of two beds in the quartzites of the Timeball Hill horizon of the Pretoria Series, in identically the same geological position as the similar ore-beds at Pretoria. Harbord gives as the analysis of the upper bed, iron 46% and silica 26%, and he states that the

opportunities for cheap mining are quite exceptional, since the bed could be worked as an open quarry, and its proximity to the railway would allow of the ore being delivered on rail at a low total cost. Other analyses indicate that the upper bed may yield large quantities of better quality. At Mount Maré, in the neighbourhood of Izerberg, in the district of Waterberg, Zoutpansberg, three lines of beds of magnetic quartzites occur in the older schists and run conformably with them. The beds are of the banded "calico rock" type, consisting of alternate layers of magnetite and silica. The upper bed is about 100 ft., the middle 20 ft., and the lower 50 ft. in thickness. The formation dips from 40 to 60° south, and working facilities would be good. An analysis shows 28% iron.

Other magnetite deposits occur in the Leydsdorp district and near Ermelo.

(*c*) In the older schists, known as the Swaziland Series, beds of banded hematite, locally known as "calico" or "ribbon" rock, occur frequently. Usually this rock consists of alternate thin bands of white silica and dark iron oxides, but in some places the iron oxides so predominate as to make the rock an iron ore. On lot No. 76 De Kaap, 5 miles south of Malelane, a deposit of banded hematite occurs bedded conformably in the country rock running east and west and dipping approximately vertically. This bed runs for many miles, but its quality appears to be best at this point, as there are no ancient workings known elsewhere. The hematite exposed in the workings is schistose in structure and extremely contorted, but the ore itself appears to be very pure though there are bands of white siliceous material up to several inches in thickness interbedded with it.

(*d*) (1) At the farms Pullenshoop No. 213 and Boschmanskop No. 277, lying approximately from 22 to 27 miles from Middelburg, hematite outcrops have been opened by a small shaft and some irregular cuttings. The ore is pure, but lies very irregularly as a layer on the surface soil. However, the evidence is at present quite inadequate, and further prospecting pits of greater depth should be sunk.

(*d*) (2) An impure manganiferous ironstone occurs near Ashbury Siding and at Lyttelton Junction near Pretoria.

(*d*) (3) On Government farm De Naauwte No. 2,239, in the Waterberg district, some 23 miles north-west of Nylstroom, an occurrence of hematite containing 56% of iron is recorded. Some old workings are to be seen, but no information is available as to the quantity of ore obtainable.

An extensive occurrence of hematite in the Crocodile River district has been reported on by A. L. Hall and C. J. N. Jourdan and by P. A. Wagner. The banded ironstones form a well-defined zone immediately overlying the dolomite, being themselves overlain by a persistent bed of chert conglomerate. The banded ironstone zone has been duplicated at the surface by faulting, giving rise to two conspicuous parallel ranges which in their highest portions attain elevations of from 1,500 to 1,900 ft. above the level of the Crocodile River, by which they are breached, the one in Vliegepoort, just below the embouchure of the Bier Spruit, and the other in Buffelspoort. These ranges contain the more important iron deposits. They are situated about 2 miles apart, trending east-north-east and west-south-west in the western part of the area, and approximately east and west in the eastern part. The strike of the banded ironstones coincides with the trend of the ranges. Their dip varies in direction from south-south-east to south; it averages about 55° in the southern range, and about 40° in the northern. The thickness of the zone where cut through by the Crocodile River in Buffelspoort is 650 ft. The whole of it is made up of banded rocks composed in variable proportions of iron oxide and finely crystalline quartz, for the most part segregated in more or less regular and well-defined layers. These are never strictly rectilinear, generally exhibiting somewhat wavy outlines. The ore-bodies occur on two main horizons, namely, at the top of the banded ironstone zone at or near its contact with the bed of chert conglomerate by which it is overlain, and at the base of the zone at or near its contact with the underlying dolomite. Apart from the hematite occurring *in situ* the disintegration of the ore-bodies has given rise to the formation of great accumulations of talus or rubble ore on the slopes of the iron ranges. This occurs in blocks ranging in weight from a few pounds to over 100 tons. It is of great purity and occurs for the most part in well-defined screes so that it could be easily and cheaply gathered. Most of the large hematite outcrops were located by following up boulders and screes of talus ore. The ore everywhere presents much the same features. It is a dense, hard, close-grained, steel-grey hematite, generally containing a small amount of magnetite, and almost without exception exhibiting a characteristic banded structure. It is of great purity and, except for one exposure, is of bessemer grade throughout, analyses showing from 60 to 67·75% of iron, from 0·55 to 6·32% of silica, and from 0·006 to 0·05% of phosphorus. It appears to be quite free from sulphur.

On the farms Tweerivier No. 823 and Leeuwpoort No. 938, North Rustenburg District, and generally in the district, hematite occurs in large masses between the dolomites and the Pretoria series. A sample at the latter farm gave on analysis 64% iron and 4·8% silica.

On Kromdraai No. 459 a deposit somewhat similar to the De Naauwte hematite occurs. It is situated about 40 miles north-east of Pretoria and 20 miles east of Pienaars River station. The ferruginous beds outcrop along the crest of a ridge, rising to a height of 300 ft. above the surrounding valleys. Their dip-slopes cover a very large area, and the actual thickness is difficult to determine, but they appear to be thickest north of the road to Schilpadfontein, in the kloof leading from Rhenosterfontein to Kromdraai. The kloof here cutting across the formation has exposed on its south side a section showing two main beds separated by some 30 ft. or more of quartzite; the lower of these beds is up to 40 ft. and the higher one not less than 60 ft. in thickness. The outcrop has been inspected along the strike for 5 miles, and appears to extend indefinitely to the north of Kromdraai, though it becomes more siliceous in character. The beds consist in the main of a quartzite breccia with a hematite cement, but massive hematite free from all included fragments occurs everywhere in the talus and detritus from the beds and was found *in situ* where searched for. Much of the deposit is high-grade, and, at a point where more than 13,000 tons are exposed, an analysis gave 84·5% ferric oxide.

Cape Province.—A. W. Rogers states that the only deposits of iron ore in the Cape Province known to exist in workable quantity are those associated with

the Lower Griqua Town beds of the Transvaal System. These beds, which in general are highly ferruginous, occur at the surface over an area of several thousand square miles, extending from the Prieska division northward to Bechuanaland, a distance of 270 miles. They are bounded on the east by the older limestones of the Kaap plateau and on the west by the younger Matsap beds. The bodies of ore are concentrations from these Lower Griqua Town beds in fissures and cavities in the underlying dolomitic limestone called the Campbell Rand formation. They consist of fragments of banded siliceous rocks cemented by hematite and silica, the silica being often partly or entirely replaced by hematite. The largest masses of this breccia are the Klipfontein hills, extending for 28 miles near Postmasburg, and the Gamagara ridge, running for about 30 miles in the Kuruman district and rising to about 400 ft. above the limestone plain. No prospecting has been done, but analyses of four specimens from outcrops on these ridges showed 38·1, 53·0, 56·3, and 67·4% of metallic iron respectively. These reserves are stated to be very large, but owing to the remoteness of coal and the principal industrial centres the ores are not of commercial value at the present time.

Natal.—Dr. F. H. Hatch reported upon the iron ore occurrences in Natal in 1910, and he was of opinion that there was not sufficient iron ore of suitable quality immediately available to establish an iron or steel industry at that time. However, since that report was made further work has been done in opening up certain deposits, and largely increased quantities of iron ore have been shown to be available.

Dr. Hatch classifies the deposits as occurring in rocks of: (1) Swaziland age; (2) Karroo age; (3) Recent age.

(1) In the northern part of the Vryheid district, between the Pongola and Pivaan Rivers, and extending to some distance south of the latter river, bands of hematite quartz schist are found associated with quartzite, having a general strike nearly north and south, and a dip of about 30° to the east. There are four chief iron-bearing belts, which with the intervening sericite schists and quartzites occupy a tract of country about 2½ miles wide. The bulk of the iron belts consist of ferruginous schists, and although occurring in large quantity are almost without exception too high in silica and too low in iron to warrant description as iron ores. The beds vary in hardness, quality, and colour from point to point. Similar occurrences of highly siliceous ores are found in Zululand, in the Umhlatuzi valley and at Isibudeni in the Nkandhla forest. There is also a large deposit of titaniferous magnetite, resembling that in the Transvaal, in the Tugela valley, about three miles down the river from Middle Drift, where a body between 20 and 30 ft. in width occurs. Two partial analyses of the rock showed 12·4 and 14·9% of titanium dioxide.

(2) In several places a bed or beds of iron ore occur below the workable coal seams in the Ecca sandstones, and Dr. Hatch states that it appears reasonable to assume that they will be found in the lower beds of the coal measures over a considerable portion of the country. The ores consist of limonite, hematite, and magnetite, occurring as a bedded deposit which in no case was found to be more than 2 ft. thick. They are all of fairly high grade in iron, low in silica, free from titanic acid, and with a phosphorus content varying from a trace up to 0·435 per cent. Ten miles north-east of Dundee, and five miles north-west of Buffalo River station on the farm Prestwick, a bed of hematite occurs, varying in width at the outcrop from 21 to 26 in. It is slightly inclined from the horizontal and is interbedded with sandstone, which, on the hanging-wall side, carries a small seam of coal, 6 in. thick. At Doornberg a bed of magnetite outcrops on the left bank of the Buffalo River, about 1 mile from De Jager's Drift station, at an elevation of 300 ft. above the railway line. The size of the ore-body is small, and apparently little work has been done to prove the lateral extent. A similar bed of magnetite occurs about ½ mile south-east of the summit of Mount Kelly, in faulted ground, the Ecca beds (usually nearly horizontal) being tilted to an angle of 60°. Sufficient work has not been done to prove the extent of the deposit. At Sweetwaters a bed of limonite 4 ft. thick has been exposed in cuttings over a distance of 500 yards, but very little work has been done to open up the deposits. Analyses showed 46 to 55% iron.

(3) Surface deposits of pisolitic iron ore are of common occurrence in Natal, as in other parts of South Africa. Dr. Hatch states that they are of irregular distribution, and found as a rule as thin accumulations at, or near, the surface. An extensive deposit occurs on the high Waterberg Sandstone plateau lying to the west of Alverstone station, on the main line between Maritzburg and Durban. The deposit consists of a rather sandy limonite and hematite intermixed with large boulders and much loose detritus. A number of small pits and trenches, extending over a distance of 700 yards near the southern escarpment, show an average thickness of about 4 ft. in which iron ore comprises about two-thirds of the total material. Dr. Hatch estimated the total quantity proved to be about 135,000 tons. A further occurrence of surface iron ore has been prospected on the east slope of Hathorn's hill, between the Greytown road and the railway, north of Mountain Rise station, on the Town Lands of Pietermaritzburg. The ore consists of concretionary limonite, which was originally deposited from solution along joints in the shales of the Ecca Series. The concretions are of the box type, the average size being that of a 6 in. cube, but some are much larger. Details regarding the deposits in the Maritzburg district are given in a statement prepared by the Pietermaritzburg Chamber of Commerce for the Dominions Royal Commission in 1913. Three kinds of ore are described as occurring in the district namely, (1) hydrated sesquioxide, occurring in beds outcropping over 30 miles at about 3,500 ft. above sea-level, and 1 ft. to 4 ft. in thickness; (2) manganiferous hematite, found in the Ecca shales in veins 1 ft. to 6 ft. thick and at an altitude of 2,250 ft.; it is stated that a million tons could be got easily and cheaply; (3) brown hematite, occurring in large quantities as a surface deposit. Stanley states that a geological examination is required to enable estimates of tonnage to be made, but that it is apparent there is a large quantity of good-grade ore available in the district, within easy distance of railways, fuel, etc., and the prospective importance certainly warrants detailed investigations.

More recent information regarding Natal occurrences is contained in a report by J. E. Vaughan, Inspector of Mines. Near Dundee, within a few

miles of the railway, deposits of limonite, hematite, and magnetite occur in the coal measures about 100 ft. below the main coal seam of the district. The deposit in one place was in the form of pockets rather than as a regular bed, and up to about 6 ft. thick. An analysis gave 3·5% siliceous matter and 61·6% iron. On another farm, the stratification is more pronounced and the bed more extensive and about 3 ft. thick. Near Newcastle a similar bedded deposit of earthy character is stated to be 5 ft. thick. An analysis shows 6·8% siliceous matter and 58·7% iron.

South-West Africa.—This territory has an area of 322,450 square miles, and is thus some 45,000 square miles larger than Cape Province. Iron ores are known to occur abundantly in the Territory among the Pre-Cambrian rocks, and in the Otavi series. According to Wagner the only deposit that has been worked up to the present is situated a few miles to the north-west of Kalkfeld, in the Omaruru district, with which it is connected by rail. The ore-body consists chiefly of a calcareous brown iron-oxide, which has been used at Tsumeb for fluxing the lead-copper ores that are smelted locally. It is found at the contact of a gabbro-like mass that is intrustive in crystalline limestone. Large deposits of pure iron ore (hematite and limonite) are reported to occur interbedded with the rocks of the lower division of the Nama System in the western part of the Kaokoveld. They have a thickness up to about 160 ft., but owing to their geographical position it is improbable that they will be worked for many years to come. The ore in these deposits contains 60% of iron. Other deposits are exposed at a number of localities in the southern part of Great Namaqualand and in Bastardland, while a bed of impure limonite occurs in Dwyka shale on the farm Eisenstein to the east of Keetmanshoop.

Economic Position in South Africa.—The iron ores of South Africa can only be utilized locally. Sea-freight, handling charges, and transport costs to the coast would appear to make the question of export impossible, especially in consideration of the fact that the ores are not of a nature to command a high price in oversea smelting centres. Professor Stanley considers that the export of pig iron is also unlikely to prove economically practicable, not only on account of the cost of production being quite as much as elsewhere, but also in view of Indian and Chinese activity in this direction. However, there is no reason to doubt that manufactured iron and steel produced in the Union would have a ready market. The proximity of the coalfields to the iron ores is a matter of great importance and one which will doubtless influence the introduction of the requisite plant. According to Professor Stanley, local requirements amount to from 50,000 to 100,000 tons of iron and steel products per annum, and the demand for iron and steel will probably continue to increase. Other ores required in steel-making, such as manganese ore, are also known to occur in many localities ; good lime is scarce, but dolomites can be obtained within reasonable distances of all the iron-ore deposits.

It is evident that the territory of the Union of South Africa contains vast quantities of iron ore, but at the present stage of the development of these deposits close estimates of the quantities cannot be given. At the same time it is possible to indicate something of the probabilities. The most important deposit in point of size is the stratified bed of highly siliceous and slightly oolitic ironstone found near the base of the Pretoria shales. Wagner estimates the quantity available by open-cut and adit mining in the vicinity of Pretoria alone to be over 400 million tons. To this must be added the known development of the same bed near Potchefstroom, Airlie, Prieska, and other places, so that it is safe to say that the reserves of iron ore containing something like 48% Fe, 18% SiO_2, 0·2% P, and 0·15% S, are of the order of 1,000 million tons or more. In the deposit of banded ironstone at Buffelshoek there are beds of hematite ranging in thickness from 6 in. to 21 ft. with over 60% Fe, something like 4% SiO_2, 0·025% P, and 0·01% S. The available amount of this ore is not likely to be less than 50 million tons, with further large quantities of siliceous ore associated with it. The bulk of the ores contain too much phosphorus to be suitable for the acid process of steel-making, and too little phosphorus and too much silica for the production of a good basic iron ; but with careful selection it seems possible that hematite pig iron suitable for acid steel could be made in quantity sufficient for the home demand in South Africa for many years.

Two small blast furnaces were erected in the Union early in 1918, one at Vereeniging, and the other at Pretoria, the local coke proving quite satisfactory. A larger blast furnace was recently erected at Newcastle, Natal, with proper accessory plant to produce 600 to 800 tons of pig iron per week.

Southern Rhodesia.—A large number of deposits of iron ore occur in Rhodesia associated with basic igneous rocks. At present the only deposits known to exist in commercial quantity and of good quality are those of Southern Rhodesia. In Northern Rhodesia deposits of magnetite are known to occur, but they are mostly titaniferous and sometimes highly so. Near Lake Bangweolo, laterites are stated to cover an enormous area (possibly 1,000 square miles or more), and, assuming that the ore carries 25% of metallic iron and has a thickness of 3 ft., Mennell points out that the available supply would be over 6,000,000,000 tons. This class of ore, however, has the disadvantage of being highly siliceous.

It is not possible to give figures for the ore reserves owing either to the little development which has been done or to the irregular nature of the deposits. The ore-body lately worked at Iron Mine Hill, between Gwelo and Umvuma, for use as a flux in the Falcon Mine copper-smelting works, yielded 29,600 tons without being exhausted. It has been worked open-cut and followed to a depth of 60 ft., but its irregular nature and the practical certainty of a change in its character below the oxidized zone make it almost impossible to calculate the probable reserves. Also, owing to the irregular nature of the chromite bodies at Selukwe, it is impossible to give an accurate estimate of the resources of the field. Bodies outcropping at the surface yielded 616,840 tons to the end of 1919, and many bodies are not yet worked. It is to be expected that other bodies will be found by sub-surface prospecting.

The engineer directing the development of the Umvukwe Hills chrome iron deposit reports that " many millions of tons of ore averaging over 50% chromic oxide will be recovered."

Swaziland.—At the present time very little is known about iron ores in Swaziland. According to information furnished by the Mines Department of the Union of South Africa, there are siliceous

iron ores in the Swaziland system and in the neighbourhood of Pigg's Peak, and some of these are of such a quality that they might be worked in favourable circumstances. Iron ore is reported to be plentiful throughout that portion of the Territory bordering the Transvaal. Owing to the absence of coal and lime, and lack of transport facilities, the deposits are of no commercial value at present. In view of these conditions, no careful investigation has been carried out on any of the deposits, and it is therefore impossible to give any idea as to their extent. The iron ore occurs as hematite in lodes, and as magnetite in schist. Ilmenite is dispersed throughout the granite. Up to the present no mining for iron ore has been carried on in Swaziland. There are no developed resources, and it is impossible to give any idea of the extent of the undeveloped resources.

Kenya Colony.—No systematic geological survey has yet been made of the Kenya Colony, and very little prospecting has been done, so that the information relating to the mineral resources of the country is very meagre. The most easterly portion of the Colony bordering upon the Juba River consists in the main of Jurassic beds, the central and northern districts near the Abyssinian frontier chiefly of gneisses and schists, etc., while that portion of the west from Nakuru to Lake Rudolf bordering upon the Uganda Protectorate consists of volcanic rocks. Magnetite occurs in the quartz rock of the Turoka Series near the eastern border of the Northern Frontier District, but there is no available information as to quantity or quality. About 3 miles north-east of Buttelu magnetite also occurs associated with quartz and augite. However, it seems probable that the quantities of iron ores available in this country will be as large as in Tanganyika or Uganda or Nyasaland, which border upon it, and very much more investigation and exploration is required into the mineral resources of this colony.

Uganda.—Iron ores of various kinds are abundant in Uganda, especially those of hydrated type, notably limonite. Limonite is frequently concentrated in the surface layers of laterites and other detrital deposits, giving them the slaggy appearance which causes those unacquainted with the true nature of the rocks to regard them as volcanic. Surface ores such as these are often worked by the natives of this Protectorate. Apart from these ores, however, others of economic importance are known, hematite and magnetite being abundant in places. Magnetite in more or less irregular masses is found in some pegmatites, and is extremely common as scattered octahedra in the lavas of the Mount Elgon Series, and may be obtained in quantity from some of the alluvials derived therefrom. It is difficult to say which district produces the best iron, but Kigezi must take a high place.

Tanganyika Territory.—The Hundussi heights on the west side of the Uluguru mountains are thickly covered with large blocks of magnetite, indicating a substantial deposit of the mineral in this vicinity. At the upper Mbakana brook, about 6 miles south-south-east of the Hundussi crest, a large quantity of blocks of rich titanic iron ore have been proved, extending about 60 miles along the road. Hematite occurs in the Upangua district. In the same region spathic iron ore occurs a few miles to the south of the Ruhuhu mountain in the Mtambalala stream. Deposits of magnetic iron ore and limonite occur in the Ruanda district and other places between Victoria Nyanza and the north end of Lake Tanganyika, and have been worked by the natives. An exploration made in 1911 by Hans Meyer revealed lateritic iron deposits west of Muscha mountain and at Karambo. South-west of Karissimbi, hematite associated with magnetite is found on the mountains on the north-west shore of Kiwu lake and is smelted at Karissimbi. There are smelters also at Muruganda village, the ore being obtained from the Mutare mountains, West Ruanda, where magnetic iron ore occurs associated with brown ironstone. Lateritic iron ore also occurs on the West Muwissi mountain near Akawugulu Brook, in the Jassenunu Mountain Pass, south-west of Ruanda, on the Kumutana Mountain on the Mogere Brook, and at many other places. Two other iron ore areas lie in the Kinga or Livingstone mountains not far from the north-east end of Lake Nyasa.

Nyasaland Protectorate.—The iron ores found in this country are chiefly hematite and magnetite. Some deposits of hematite outcrop on the Mvai and Dzonze ridge. It is stated that 53,000 tons of this ore is in sight. A sample of magnetite from the lower sandstone in Fonkonyowa Valley gave a high percentage of iron. The ore consists of numerous rounded fragments of magnetite. In the Sumbu district, a concretionary iron ore occurs, and though only of medium quality, is said to be very extensive. The specimen analysed was a soft iron ore of the limonite class. On the top of the Namitawa Hills, brown ironstone occurs in loose fragments, indicating that bedded deposits may be found at some future time. A reddish-brown limonitic ironstone is found a little to the north of the Northern Rukuru River, in lenticular beds in sandy shales, but never more than 1½ ft. thick. It is, however, of too poor a quality to be of economic value, and its extent does not appear to be large. A brown iron ore occurring in the sedimentary beds east of Panyanole village is of much better quality, though the phosphorus percentage is rather high.

Nigeria.—Investigations carried out by the Mineral Surveys of Nigeria have shown that iron ore is widely distributed over the Colony and Protectorate. The most important deposits are those of Mount Patti, near the junction of the Niger and Benue Rivers. This hill rises 1,050 ft. above the level of the river. Its summit is several square miles in area and consists of bedded iron ores. The uppermost bed consists of pebbly ironstone 6 to 12 ft. thick. In some places this bed is underlain by earthy ironstone, though usually the underlying deposit consists of compact, pisolitic iron ore. Lower down, the iron ore is less compact and becomes oolitic. At a distance of about 100 ft. below the summit, bands of ferruginous sandstone begin to appear, and these pass into the red and white grits and sandstones of the lower part of the hill. The ores all belong to the limonite group and are divisible into three classes: (1) earthy iron ore, generally porous and sometimes pebbly; (2) dull concretionary iron ore; (3) compact and lustrous concretionary iron ore. The first variety occupies the summit of the hill, and forms a bed of variable thickness (6 to 12 ft. or more) capping the other deposits. It contains too much silica and too little iron to be suitable for export as an iron ore. Varieties (2) and (3) form a series of beds of variable thickness, the thickness near Lokoja, where the outcrop was examined, being about

80 ft. It is not unlikely that these beds prevail all over Mount Patti, but a more thorough survey would be necessary to establish this conclusion. The summit of Mount Patti has an area of at least 10 square miles, and if the conditions observed near Lokoja prevail throughout this area the deposits must contain an immense amount of iron ore. Assuming that the beds represented by (2) and (3) have an average thickness of 75 ft. throughout the area, the amount of ore available on Mount Patti alone must be about 2,000,000,000 tons. This ore could be open-worked throughout the whole extent of the occurrence, as the overburden is comparatively thin. The ore available would probably contain, on the average, at least 50% of metallic iron, but would have the disadvantage of being phosphatic. This concretionary ore could probably be separated into two qualities represented by varieties (2) and (3), of which the latter contains rather more iron. The deposits are very favourably situated for exploitation. The Niger is close at hand, and it might be practicable to carry the ore from the quarry to the riverside by a system of aerial ropeways. The ready accessibility of the deposits, therefore, makes them of considerable interest, but unfortunately the ore is not of high quality, and for that reason it probably could not be exported under present conditions. If, however, in the future, prices for iron ore rise above their present level, owing to a failure in the supply of other and better iron ores or to other economic causes, these deposits will be worth working and will prove an asset of great value. Hence, it is desirable that a careful survey should be made of these iron ore deposits, not only at Mount Patti, but also in the surrounding districts, where iron ores are known to occur in large quantities.

The volume gives particulars also of deposits in Gambia, Sierra Leone, the Gold Coast, Egypt, and the Soudan. In the western regions the ore is largely of the nature of low-grade laterite, and in Egypt and the Soudan there are igneous ores and manganiferous ores of the Carboniferous period, but their extent is not defined. It is not necessary to reproduce details here.

MERRILL-CROWE PROCESS AT MODDERFONTEIN B

The June *Bulletin* of the Chemical, Metallurgical, and Mining Society of South Africa contains a paper by S. Newton and L. L. Fewster describing the Merrill zinc-dust process for precipitating gold from cyanide solutions of Modderfontein B, and the later addition of Crowe vacuum plant for removing oxygen from the solutions. The zinc-dust method was adopted in 1911, when the Modderfontein B metallurgical plant was built, and the Crowe process was added in September, 1921. The authors first describe the plant as originally designed and then the modifications involved in the addition of the Crowe process.

The original plant consists of the usual solution clarifiers, solution sumps, zinc feeder, two triplex Gould pumps, one small centrifugal pump, and two Merrill precipitation presses. A fault in design was that the Gould pumps are on the ground level, whereas the "steadyhead," or general solution supply sump, is below ground level, thus making a flooded pump suction impossible without constructional alterations. This point, apparently overlooked in the original design, had to be rectified when the Crowe method was installed.

The sumps directly connected with the precipitation plant as distinct from sand and slime treatment sumps are: One slime solution settlement tank, 45 ft. by 7 ft., cone bottom; three gravity sand clarifiers, 45 ft. by 6 ft., flat bottom; one steadyhead or general solution supply sump, 40 ft. by 4 ft., flat bottom; one filtrate or press effluent intermediate sump, 25 ft. by 5 ft., flat bottom; one filtrate or precipitated solution storage sump, 50 ft. by 8 ft., flat bottom; one strong solution sump, 20 ft. by 8 ft. flat bottom. The two original Gould pumps had plungers of 7 in. and 8 in. diameter, strokes of 8 in. and 10 in., and capacities of 50 tons and 60 tons per hour respectively. The smaller pump has since been replaced by a larger one of the same type with 8 in. plungers and 12 in. stroke, which at the present speed of 44 revolutions per minute has a capacity of 88 tons per hour.

The original Merrill zinc-feeder was of the belt type, the control of the feed being by means of cone pulleys driving pawl gears, the zinc to be fed being spread along the belt. This type of feeder had been tried previously at New Modder, but was discarded on account of irregular feeding owing to the belt slipping. The spiral or worm feed was therefore installed at Modder B. It is simple and consists of a hopper containing the zinc, through the bottom of which a long screw operates, the speed of the screw controlling the feed, theoretically. Owing to the peculiar packing properties of zinc dust, this method of feeding had to be discarded. The next feeder to be used was made on the mine and was quite novel, as far as the authors are aware. This Modder B feeder was designed and made in 1914 by Mr. Paterson, the cyanide fitter, and has been used satisfactorily until the installation of the Crowe process. It allowed of the finest adjustment required at the time, about 150 lb. per 24 hours, and gave an almost continuous feed. Its description is as follows: The cone has a bracket carrying a white iron pinion and shaft which revolves on two bearings on the base plate. Above the pinion is a white iron bar which takes all the weight of the cone hopper containing zinc dust. When the press pump starts it causes the feeder pinion to revolve at about 14 r.p.m., resulting in a vibrating and up-and-down movement of the hopper, which prevents any tendency to choking of the regulator cock at the bottom of the hopper. This feeder has practically only one wearing part, the white iron bar, which requires changing about three times a year. Until October, 1921, the zinc from the feeder had been washed down a 3 in. pipe by a small amount of solution from the Gould pump delivery, together with a continuous drip of lead nitrate solution and 10 tons per hour of strong solution (0·05% KCN), supplied by a small centrifugal pump used to maintain strength of general supply of solution for precipitation. Subsequently reversion was made to the belt type of feeder with simple modifications which have resulted in an absolutely controllable feed. This is obtained by using a leather belt for carrying the zinc dust, the edges of which are punched with ⅜ in. holes, pitched to mesh over sprockets on the head and tail pulleys, the belt being driven by chain

and gears. There is thus no slipping of the zinc feed belt or intermittent motion due to pawl action. With the reversion to this method of feeding came the introduction of the cone fitted with float and plug attachment, arranged so as to maintain a practically constant solution level in the cone and forming an effective seal which prevents air from being drawn with the zinc emulsion into the pump. Inserted in this cone is a vortex mixer which draws down and wets the zinc particles which otherwise would have a tendency to float on the surface of the solution. In all types used the zinc feeder has been driven from the pinion shaft of the Gould pumps.

There are two Merrill precipitation presses originally of 40 units each but since extended to 46 units each. A unit consists of a standard 52 in. triangular hollow frame and double-sided drain plate (constructed on similar lines to the more familiar Johnson filter-press), and the feed pipes are so arranged that the solution and precipitant enter from the bottom of each hollow frame. The solids, gradually accumulating in the frames, are kept in constant agitation and the best efficiency in zinc dust precipitation is thus obtained. The solid frame or filter plate has two top discharges. The plates are covered with a double thickness of 12 oz. cotton duck, which have a life of about four months. Experience has shown that one of the main essentials of good precipitation is a perfectly clear solution. Previously the various sand and slime solutions were precipitated separately, but recently only one solution or one combination of solutions has been precipitated. The whole of the loading solution obtained from the Butters plant, together with the first portion of the wash solution, 20 minutes or 30 minutes of the total wash of 60 minutes, is delivered to the settling tank, and thence through the three clarifiers placed in parallel to the steadyhead. Into the steadyhead is also run the first 30-36 hours of the first leaching from the sands treatment tanks. The pumping system is arranged so that any desired solution from the sumps or steadyhead can be pumped at will, the pump delivery being connected by two pipes direct to the precipitation presses. Two gauges, one near the pump and the other between the presses, indicate pressure conditions. When commencing a fresh cycle of precipitation, zinc dust is fed in at the rate of 500 lb. the first day, 350 lb. the second day, 200 lb. the third day, and then about 150 lb. for each of the remaining days of the run. The gold cyanide solution, together with the zinc precipitant, is pumped into the precipitation presses where the solution must pass through a uniform filtering layer of fine-grained precipitant, thus ensuring contact between each metal-bearing molecule and the precipitant, and leaving behind in the press the precipitated metals and the unconsumed zinc dust. The effluent from the press, or filtrate, passes to an intermediate sump, from which it is pumped to the Butters plant as wash solution, or to the sands plant for last washes. Drip samples are taken from the pump suction column prior to the entry of the precipitant for head values, and similar samples are taken from the filtrates. Two-hourly samples of the filtrates are taken and tested colorimetrically. Should precipitation go off slightly (anything over 0·04 dwt. tail) filtrate samples are tested more frequently until the cause is located and remedied. The most common troubles with precipitation are shortage of zinc feed and low cyanide strength, although the cause of unsatisfactory precipitation at times has been extremely difficult to locate.

When the consumption of zinc was in the neighbourhood of 0·166 lb. of zinc per ton milled there were normally two clean-ups per month, but during the period of experimental work or investigation clean-ups have been irregular in number, the pressure and pump duty determining the date of the clean-up. Prior to opening the press for clean-up, air is blown through to displace as much moisture as possible. A shallow tray on wheels is placed beneath the press and the closing piece of the press is withdrawn. The accumulated cake of precipitated metals and surplus zinc, etc., is removed from the hollow frames and cloths by means of scrapers. The top cloth is subsequently removed, folded up, and placed in a locker until such times as the cloths are washed, either by hot water or treated with hydrochloric acid. After examination they are either passed for a further period of usefulness or condemned, burnt, and smelted. The undercloths are used as top cloths as required and replaced by new ones. When the zinc-dust process was first commenced at Modder B the precipitate from the presses was acid treated, briquetted, scorified, and cupelled, but this method not being a success it was discontinued in favour of acid treatment, calcining, and pot smelting, which in turn gave way to acid treatment, Tavener furnace smelting, and cupelling. At the present time the precipitate is smelted in the Tavener furnace without acid treatment.

Even previous to the adoption of de-aeration the efficiency of the process depended to a great extent upon the elimination of the air contact with the solution after the addition of the zinc dust. The quality of the zinc dust employed as precipitant is very important, some supplies of zinc dust having been found to be useless as an efficient precipitant. The zinc dust, which should be free from oxide, is passed through a 90 mesh sieve to remove any large particles of foreign matter. Cyanide and alkalinity strengths require careful control, the solution being kept to at least 0·107% KCN, and about 0·02% CaO.

The reducing power of solutions when it passes beyond certain limits affects precipitation, and its source is to be found in the mill water circuit which is made up from underground or mine water. Control of reducing power is maintained by testing the water with N/10 potassium permanganate and adding the requisite quantity of chloride of lime or sodium hypochlorite, which is produced on the mine at a small cost by the electrolysis of brine.

It had been the custom at Modder B until about eighteen months ago to have a constant drip of lead nitrate solution (24 lb. per shift) entering the circuit along with the zinc feed. When the drip of lead nitrate was discontinued and the lead nitrate solution added to the circuit via the clarifiers a very marked reduction in zinc consumption was quickly obtained. Whereas previously the consumption of zinc dust had been about 0·16 lb. per ton milled or 0·17 lb. per ton of solution precipitated, it fell to 0·10 lb. per ton milled or 0·12 lb. per ton of solution precipitated. This is apparently explained by the possibility of some of the particles of zinc becoming so heavily coated with metallic lead that they were unable to precipitate any gold from the cyanide solution. It

is conceivable that precipitation would be considerably affected at times by the greatly variant strengths of lead nitrate solutions.

The authors proceed to deal with the Crowe process. The Transvaal Chamber of Mines conducted an investigation into its efficiency and practicability at the City Deep, where zinc shavings are used as the precipitant. As a result of these local trials, plants have been installed at various mines on the Witwatersrand, in connexion with both zinc dust and with shavings. Cyanide solutions going to precipitation under ordinary conditions are more or less saturated with air absorbed during agitation in slime treatment, in sand treatment, and in open sumps. The Crowe method removes the air by passing the solution through a vacuum receiver immediately prior to the addition of the zinc dust precipitant. The additions involved in the adoption of the Crowe process form a complete and independent unit in themselves, making it possible to isolate the de-aeration portion of the equipment and run on previous practice, as would be necessary, for instance, if the vacuum pump broke down for any length of time. The additions consist of a solution booster pump, vacuum pump, vacuum receiver, and necessary connexions, valves, etc. The booster pump is a 6 in. Sulzer with 40 ft. head, which forces the gold-bearing cyanide solution from the steadyhead to the top solution inlet of the vacuum receiver. The vacuum receiver is a cylindrical iron tank 12 ft. high and 8 ft. diameter, placed at a height of approximately 35 ft. above the valve chests of the Gould pump, thereby maintaining a flooded suction of the Gould pump, this height being necessary to overcome the effect of the vacuum in the receiver. From an efficiency point of view this flooded section is imperative in order to prevent ingress of air through pump glands. The upper portion of the vacuum receiver is filled with wooden grating through which the solution from the booster pump passes. While not actually atomized, the solution exposes sufficient surface to the effect of the vacuum that its dissolved oxygen content is reduced from about 6 mgm. to 0·5 mgm. per litre. The lower portion of the receiver acts as a small storage tank for the Gould pump, the supply to the receiver being controlled by a butterfly valve in the booster-pump delivery-column actuated by a crank rod connecting the valve with a ball-float inside the receiver. A gauge glass indicates the height of the solution in the receiver and a pressure-gauge on the booster-pump column immediately below the butterfly valve shows the pressure acting against the pump. The vacuum is maintained by a Worthington feather-valve water-cooled vacuum-pump connected by 1 in. piping to the top of the vacuum receiver. The gauge usually shows 22 in. of vacuum. The de-aerated solution passes from the bottom of the receiver to the Gould pump suction, receiving on its way the zinc-dust precipitant which is fed as described previously. The vacuum-pump and receiver have a capacity of 3,000 tons per 24 hours, but a duty of 2,050 tons suffices at present.

The operation of the process is continuous and practically no operative attention is required beyond adjusting the solution duty and the keen observation of details as for the old process. The routine cycle of operations is simple; the gold, cyanide, and alkalinity values have to be controlled as previously, and samples are taken and gold tests performed. Oxygen tests are also carried out as part of the routine.

After clean-up the presses are re-dressed, closed up, the rate of flow of solution fixed, and zinc is fed in at the rate of 40 lb. in the first 45 min., 40 lb. in the next 75 min., and 40 lb. in the next 120 min. The filtrate values are usually down to 0·04 dwt. in from one to two hours when the zinc feed is cut down to 4 lb. per hour. The filtrate samples are continually being tested colorimetrically until good precipitation is established.

Since the introduction of the Crowe method the acid treatment of the zinc-gold slime, as mentioned before, has been discontinued and direct Tavener furnace smelting of the precipitate resorted to on account of the decreased consumption of zinc and increased value of precipitate and smaller amount of precipitate treated. Should, however, the zinc consumption be still further reduced, it will possibly mean that pot smelting of the slime will be advisable.

From the results of one or two recent determinations it has been found that the zinc-gold slime from the clean-up now contains about 40% moisture and the dried slime is reducible in weight by about 45% by treatment with sulphuric acid.

The chief disadvantage, if it may be so termed, of de-aeration applied to zinc-dust precipitation from the purely practical side is due to the smaller amount of precipitant used and consequent higher grade of precipitate, which results in a more slimy and less permeable cake in the press. Experiments have been carried out employing various materials as added filtering mediums, such as ground coke, sawdust, and kieselguhr in order to obtain a more porous cake in the press. So far experience shows that kieselguhr is probably the most satisfactory added filtrant.

Mining in British Guiana during 1921.—The Report of the Lands and Mines Department of British Guiana for 1921 contains a review of mining progress in that colony during the year. The output of gold during 1921 from all sources was 12,828 oz., this being a small increase of 136 oz. on 1920. Little prospecting for gold was done and no new fields were discovered. Placer washing accounted for 6,058 oz. The Guiana Gold Co. continued dredging operations on the Konawaruk River, and the Minnehaha Development Co. on the Mahdia Creek. The gold obtained by these two dredging companies was 6,770 oz., which shows an increase of 532 oz. on the previous year's production. The Guiana Gold Co. had three dredges in operation during the year, and produced 4,234 oz. of bullion. The quantity of material treated was 417,600 cu. yd., giving an average recovery of 4·86 grains per cu. yd. The Minnehaha Development Co. operated for 10 months during 1921 with one dredge and treated 105,985 cu. yd. of material for a production of 1,946 oz. of bullion, giving an average recovery of 8·8 grains per cu. yd. No lode-mining operations were carried on during the year. During the year, 507,200 diamonds weighing 102,603$\frac{5}{8}$ carats of an estimated value of £329,347 were declared, as compared with 234,456 stones weighing 39,362$\frac{5}{8}$ carats of a value of £281,535 in 1920.

The production of diamonds has increased by 600% in two years, that is, from 16,000 carats in 1919 to 102,000 carats in 1921, and there are indications that the production during the current year will

exceed that for 1921. This boom in the production of diamonds caused a rush to the Kurupung district, Mazaruni River, and it was estimated that at the close of the year some 5,000 men were carrying on working operations in this locality and some lucky finds were made. The diamonds were all won from alluvial workings and the entire output averaged 5 to the carat, but a considerable proportion ran to a carat and over. Generally they were of very fine quality, and as there is a large demand at present for stones running from $\frac{1}{2}$ a carat to 6 or 7 carats they were eagerly sought by the trade. The largest stone weighed $29\frac{5}{16}$ carats, and was sold locally by the finders to a licensed trader in Georgetown who conveyed it to New York where, judging from newspaper accounts and inquiries which have followed, a mild sensation was created. The proved diamondiferous area extends in a northerly and southerly direction from the Potaro River to the Cuyuni River, a distance of 150 miles. It extends eastward for 40 miles from the foot of the Pakaraima Mountains. The Mazaruni fields, which are the most important, are situated in about the centre of this area. They extend from Tiboku Falls on the Mazaruni River upwards to Peaima Falls, a distance of 110 miles, and embrace all the tributaries of the Mazaruni between these points. They include also the upper part of the Puruni River and its tributaries. The scene of the present boom is Tacouba Creek, a tributary on the right bank of the Kurupung River, which joins the Mazaruni on its right bank at a point about 175 miles from the junction of the Mazaruni and Essequibo Rivers at Bartica, a village situated 45 miles from the Atlantic Ocean and reached by river steamer from Georgetown. The rocks met with in the Tacouba Creek area are dolerite, conglomerate (including sandstone), and granitite, of which dolerite is the most recent and granitite the oldest. The surface deposits in which the diamonds are found consist of the detrital products of these rocks. The gravel is derived almost entirely from the conglomerate and consists of quartz pebbles of all colours. The diamonds are accompanied by heavy minerals such as tourmaline, ilmenite, and gold in greater or less quantity. The primary source of the diamonds is no doubt a series of volcanic pipes, or large areas of very basic rocks; but so far no trace of these has been found, except an exposure of mica-gabbro in the Issenaru-Haimarakka district.

No geological examinations, prospecting, or drilling for mineral oil were carried out during the year. If oil is to be found on the coast lands of the colony it can only be located by deep drilling, as the heavy deposit of alluvium along the coast extending inland completely obliterates the underlying geological features. The surface indications which have been seen so far by oil technologists have not, unfortunately, proved sufficient to induce them to recommend their principals to embark on a drilling enterprise; but possibly the investigations now proceeding in the delta of the Orinoco in Venezuela, if successful, may supply data which will warrant systematic tests of the areas in the north-western district of the colony where the presence of pitch and the occurrence of gaseous emanations have created interest in the past.

Waihi Geology. — As already mentioned in the MAGAZINE for July, P. G. Morgan, director of the New Zealand Geological Survey, has made an examination of the Waihi goldfield. It will be remembered that Dr. Mackintosh Bell and Colin Fraser made a survey of this region in 1911. Quotations from their report (Bulletin No. 15) were published in the MAGAZINE for June, 1913.

Mr. Morgan has written a preliminary report on his re-survey for the *New Zealand Journal of Science and Technology*, vol. v, No. 2. Briefly his verdict is favourable to a prolongation of the life of the goldfield. Extensive lateral exploration and sinking to a depth of 2,000 ft. are recommended. Herewith we give an outline of Mr. Morgan's views and recommendations.

The principal reasons for making a new survey were: (1) As time went on some of the conclusions advanced in Bulletin No. 15 were found to be untenable, and others at least highly doubtful; (2) new data afforded by the deeper workings of the Waihi and Grand Junction mines have become available during the past ten or eleven years; (3) the marked though perhaps not great evolution of new methods and more especially of new ideas in the science of economic geology during the decade 1911–21 has rendered reconsideration of Waihi geology advisable; (4) since 1911 work in the deeper levels of the Waihi and Grand Junction mines, while continuing to yield considerable amounts of payable ore, has failed to reveal any of those high-grade ore-bodies known as bonanzas, and therefore it was desirable to ascertain if geological reasoning would point to the presence or absence of such ore-bodies either in depth or in areas laterally outside the ground already explored.

In order that a true perspective may be obtained, it is necessary in the first place to discard certain errors or probable errors and fallacies which have gained more or less vogue. Briefly, these are: (1) The hypothesis of an intrusive dacite or quartz-andesite mass which contains the more productive ore-bodies; this view, advanced in Bulletin No. 15, has retarded lateral exploration; it may safely be regarded as wholly incorrect; the suggestion made by H. Foster Bain that in part the Waihi quartz andesites are sills, finds no support from the field or underground examinations made during the writer's survey; Jarman's view is the same as that of the writer. (2) The hypothesis that the primary lode-filling consisted mainly of carbonates; field and microscopic examinations satisfactorily disprove this view. (3) The hypothesis that most of the lode-material represents filling of open spaces. (4) The hypothesis of a critical level, so far as any depth yet reached is concerned. (5) The view that slight variations in the original nature of the enclosing rock may cause great variations in the amount and quality of the ore. (6) The fallacy that ore-deposition is dependent upon comparatively insignificant variations in the nature of the alteration undergone by the wall-rocks, the fact being that lode-formation and alternation of the wall-rocks are different though connected effects of the same causes. (7) Failures to distinguish between post-mineral changes and events, which cannot have had any bearing on the original ore-deposits but may have had much to do with the formation of secondary ore, and those changes or events which preceded or accompanied lode-formation.

Among the positive results of the re-survey are: (1) Some of the geological boundaries as previously mapped have been rectified, and various errors have been corrected. (2) The intrusive dacite or quartz-andesite hypothesis, it is hoped, has been finally shelved, and a return to earlier, more correct,

views has been made. (3) The lode-bearing rocks have been found to be much faulted, and the significance of this in relation to lode-formation has been clearly ascertained. (4) A partly new hypothesis of lode-formation at Waihi has been evolved ; this satisfactorily explains many of the observed facts, and to some extent favours deeper exploration. (5) Data supporting enrichment of portions of the lodes by descending solutions (so-called secondary enrichment) have been obtained. (6) The policy of lateral exploration to the limits of the propylitized quartz andesites is shown to be sound. (7) Deeper exploration to perhaps 2,000 ft. is justified, for it can be shown (*a*) that secondarily enriched ore may exist to or near that depth (not, however, in lodes carrying much calcite), and (*b*) that new primary ore-bodies are a distinct possibility. (8) Since the ore-bearing quartz andesites have a general dip to the south-east there is a possibility that ore-bodies at even greater depth than 2,000 ft. may exist in that direction. (9) The existence of a body or bodies of secondary ore at considerable depth in the western part of the Waihi mine is shown to be probable. (10) The existence of secondary ore at considerable depth in the lodes of the Rosemont-Silverton hills and elsewhere, although not perhaps strongly probable, is shown to be more than a shadowy possibility.

The full report giving Mr. Morgan's hypothesis of lode formation at Waihi is awaited with interest.

Carbon Black. — Bulletin 192 published by the United States Bureau of Mines, by R. O. Neal and G. St. J. Perrott, contains some information relating to the manufacture of carbon black from natural gas. Forty thousand million cubic feet of natural gas is used annually in the United States in the manufacture of carbon black, which is used extensively in the rubber industry, something like 20,000,000 lb. going annually into the manufacture of automobile tyres. From 10,000,000 to 12,000,000 lb. of carbon black is used annually in the manufacture of printers' ink, and from 4,000,000 to 5,000,000 lb. in the making of stove polish. The product enters also into the composition of black and grey paint, phonograph records, carbon paper, crayons, typewriter ribbons, glazed paper, tarpaulins, black leather, artificial stone, and insulating materials. In normal times the United States exports probably 10,000,000 lb. of carbon black in a year. Confusion exists in the use of the terms lampblack and carbon black. Carbon black is the fluffy, velvety-black pigment produced by burning natural gas with a smoky flame against a metal surface. In its physical characteristics it is entirely different from lampblack, which is made by burning oil or other carbonaceous material with insufficient air and collecting the smoke in settling chambers. Popularly, these blacks are supposed to be pure carbon, but as a matter of fact they are complex mixtures of hydrocarbons and other organic substances which may contain much mineral matter. The process of manufacture most widely used in the manufacture of carbon black at present is the so-called channel system, in which the black is deposited on the smooth undersurface of steel channels by lava-tip burners. The mechanism is enclosed in sheet-iron buildings in order that the amount of air may be regulated. Full particulars of the process of manufacture are given in the bulletin. Whether natural gas is of greater economic value for the manufacture of carbon black than for other industrial purposes is a question that will depend on the conditions existing in each locality where a large supply of natural gas is available. The policy of the Bureau of Mines is that carbon black should be made when gas is produced in isolated sections with no present or reasonably prospective market for gas being produced, when gasoline (petrol) has been extracted, and when practical and modern and improved methods are used. At present there is considerable agitation for and against laws restricting the use of natural gas for the manufacture of carbon black. The matter has been the subject of considerable agitation and legislative consideration in Wyoming. The carbon-black industry has been established in Pennsylvania for over 40 years, and in West Virginia for more than 20 years. The latter state still produces more than 50% of the entire supply. Neither of these states has passed any laws restricting the use of natural gas for this purpose. The carbon-black manufacturers claim that they use the best manufacturing processes that have been developed and that they produce a commodity of acknowledged utility.

SHORT NOTICES

Mine Survey. — in the *Colliery Guardian* for September 8, T. G. Bocking gives his method of surveying steep workings with mining dials.

History of Mining and Metallurgy. — In the *Engineering and Mining Journal-Press* for September 2, H. H. Manchester commences a series of illustrated articles on the history of mining and metallurgy from the earliest times.

Japanese Converting Process.—In *Mining and Metallurgy* for September, Ichiro Omori describes the Mabuki copper-converting process, an old method used in Japan.

Electrolytic Zinc. — In the *Engineering and Mining Journal-Press* for September 2, J. T. Ellsworth gives an outline of the principles underlying electrolytic zinc practice.

Antimonial Gold Ores. — In the July *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa, H. R. Adam describes experimental work in connexion with the treatment of the antimonial gold ores found in the Murchison Range, particularly in connexion with the application of flotation thereto.

Copper Leaching. — In the *Engineering and Mining Journal-Press* for September 9, P. R. Middleton writes on the use of ferric salts as solvents in the leaching of roasted copper ores.

Iron Smelting. — A paper was read by A. K. Reese, of Cardiff, at the September meeting of the Iron and Steel Institute, on the bases of modern blast-furnace practice.

Copper Leaching. — In the *Engineering and Mining Journal-Press* for August 26, Joseph Irving gives particulars of the experiments on leaching copper ores with sulphurous acid conducted at the mines of the Nevada-Douglas Consolidated Copper Company.

Aluminium Estimation. — A paper by J. E. Clennell read before the September meeting of the Institute of Metals describes experiments on the oxide method of determining aluminium in presence of iron and other impurities.

Chinese Coal Mining. — The *Engineer* for September 22 describes the coal-mining industry in North China of the Kailan Mining Administra-

tion, of which the English company, the Chinese Engineering and Mining Co., forms an integral part.

RECENT PATENTS PUBLISHED

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.*

4,672 of 1921 (184,206). J. G. WILLIAMS, London. Improved method of producing ammonium phosphate fertilizer from rock phosphate and ammonium sulphate.

4,782 of 1921 (184,501). SOCIEDAD METALURGICA CHILENA CUPRUM, Valparaiso. In the treatment of complex silver-gold ores before leaching, spraying the incandescent ore with a solution of a nitrate or nitrite.

11,786–7 of 1921 (184,843–4). J. M. SKELLEY, J. MERSON, and CONTINUOUS REACTION CO., LTD., London. In the production of ferro-tungsten, ferro-chrome, and ferro-molybdenum by the alumino-thermic process, using silicon or ferro-silicon together with sodium nitrate in place of the aluminium.

12,205 of 1921 (167,741). BLEI UND SILBER HÜTTE BRAUBACH A.G., Braubach on Rhine. In the treatment of antimonial gold ores and the like in the blast-furnace, a method for volatilizing the antimony, arsenic, etc., and producing a slag which contains the gold, afterwards adding a metal such as copper to collect the gold from the slag.

13,467 of 1921 (184,132). G. CARTERET and M. DEVAUX, Paris. Method of making titanium oxide pigments.

13,622 of 1921 (165,082). SOCIÉTÉ D'ELECTRO-CHIMIE ET D'ELECTRO-METALLURGIE, Paris. In electrolytic refining using a cathode of iron coated with a film of copper so that the refined metal deposited on the cathode may be more easily detached when completed.

14,189 of 1921 (184,880). H. PLAUSON, Hamburg. Separating kaolin from silica and silicates by giving the crude material a severe pulverization sufficient to make the kaolin unsettleable, that is, of colloid condition, while no such effect takes place with the minerals mixed with them ; the addition of water glass assists the separation as a dispersion accelerator.

14,460 of 1921 (184,897). W. WHALEY, Knoxville, Tennessee. Improvements in shovelling machines.

15,179 of 1921 (184,912). W. L. TURNER, Caldy, Cheshire. In the alumino-thermic method of making ferro-molybdenum from molybdenite, the addition of manganese oxide to act as a de-sulphurizing agent.

15,815 of 1921 (184,628). F. E. ELMORE and CHEMICAL AND METALLURGICAL CORPORATION, London. In the inventor's acid-brine process for the treatment of complex lead-zinc-silver ores, a method for increasing the dissolution of the silver with the lead and leaving the zinc sulphide free from silver. This result is effected by eliminating the sulphuretted hydrogen formed during the reaction, by adding sulphurous acid.

16,871 of 1921 (184,639). H. HARRIS, London. Apparatus employed in refining metals of low melting point such as lead.

17,499 of 1921 (184,948). G. CARTERET and M. DEVAUX, Paris. Extracting titanium from iron-titanium compounds in the form of volatile tetra-chloride by the action of chlorine gas.

17,506 of 1921 (182,879). T. KOLKIN, Vadheim, Norway. Improved electrodes for use in the electrolysis of fused salts, as in the production of sodium from common salt.

17,948 of 1921 (184,015). R. HEGINBOTHAM and P. RAYNER, Sheffield. Dies for making or sharpening rock and coal cutting tools.

19,363 of 1921 (167,164). L. WALDO, New York. Method of producing metallic magnesium by intimately mixing powdered magnesia and aluminium and subjecting them to heat in vacuo.

19,474 of 1921 (182,699). GENERAL ELECTRIC CO., Schenectady, New York. Method of producing filaments of alloys of tungsten with other metals such as iron and zirconium.

19,538 of 1921 (172,926). P. W. NEVILL and H. SOANES, Perth, W.A. Extracting copper from its ores by the process described by the inventors in the MAGAZINE for August.

22,216 of 1921 (185,012). A. DE W. MULLIGAN, London. Fusible alloys such as are used as temperature indicators for bearings, etc., so composed as to be tougher and harder than those usually used.

22,607 of 1921 (179,133). SIEMENS-SCHUCKERT CO., Berlin. Method of balancing the weight of mine-cage ropes.

26,787 of 1921 (184,402). H. BARDT, Santiago, Chile. In dissolving copper or other metal from ores, etc., treating with sulphuric and nitric acids under pressure in an autoclave in the presence of a catalyser.

30,625 of 1921 (183,768). E. MÖLLER, Brackwede, Germany. Method for the electrical precipitation of suspended particles, especially such as are in a fine state of division from electrically insulating fluids, especially gases, consisting in submitting the fluid to a single- or multi-stage bilateral treatment with the object of agglomerating the finely subdivided suspended particles by mutual attraction and causing them to flocculate, and then submitting the fluid to treatment in the electrical field of unilateral discharge.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

Fourth Report on Colloid Chemistry and its General and Industrial Applications. Paper covers, 390 pages. Price 5s. 6d. net. Prepared by the Department of Scientific and Industrial Research for the British Association. Among other papers in this Report are the following : Application of Colloid Chemistry to Mineralogy and Petrology, by Dr. Alexander Scott ; Molecular Attraction and the Physical Properties of Liquids, and Concentration of Ores by Flotation, by Edwin Edser ; Role of Colloids in Electrolytic Metal Deposition, by H. J. S. Sand.

Quicksilver. Pamphlet, 40 pages. Price 1s. net. London : Imperial Mineral Resources Bureau.

Vanadium. Pamphlet, 20 pages. Price 6d. net. London : Imperial Mineral Resources Bureau.

Bibliography of South African Geology to the end of 1920. By A. L. HALL. Paper covers, 380 pages. Price 10s. 6d. net. Published by the Geological Survey of the Union of South Africa.

The Geology of the Country around Heidelberg. By DR. A. W. ROGERS. Pamphlet, 84 pages, and coloured map. Price 8s. 6d. net. Pretoria : The Geological Survey.

Transvaal Chamber of Mines; 32nd Annual Report, 1921. Cloth, quarto, 272 pages. Published by the Transvaal Chamber of Mines (London Office: 202, Salisbury House, E.C. 2).

New Developments in Ore Treatment on the Rand. By G. A. and H. S. DENNY. Pamphlet, 56 pages. London: *The Mining Journal.* The authors discuss the all-sliming method as applied to the Rand.

Design and Operation of a Low-Pressure Absorption Plant. By W. P. DYKEMA and A. A. CHENOWETH. Technical Paper No. 263, issued by the United States Bureau of Mines. This bulletin deals with a new process for the recovery of gasoline (petrol) from natural gas.

Silver Enrichment in the San Juan Mountains, Colorado. By EDSON S. BASTIN. Bulletin 735 D, issued by the United States Geological Survey.

Application of the Geophone to Mining Operations. By ALAN LEIGHTON. Pamphlet; 34 pages. Technical Paper No. 277 published by the United States Bureau of Mines.

The Mines Handbook, Vol. XV. By WALTER HARVEY WEED. Cloth, octavo, 2,250 pages. Price £3 10s. net. Tuckahoe, New York: Mines Handbook Co.; London: Technical Bookshop, 724, Salisbury House, E.C. 2.

"Empire Forestry": Journal of the Empire Forestry Association, Imperial Institute. A new quarterly magazine; price 4s. net per issue. London: Macmillan & Co., Ltd.

COMPANY REPORTS

New Modderfontein Gold.—Yearly reports now coming from Rand companies have to be read with the remembrance of the strike early this year, which stopped production for two months, so that comparisons with the results of previous years are not easy to make. During the year ended June 30 last there was raised from the mine of this company 1,064,688 tons of ore, and, after the rejection of 11% as waste, 949,050 tons averaging 9·63 dwt. per ton was sent to the stamps. The yield of gold by amalgamation was 289,877 oz., and by cyanide 159,891 oz., making a total of 449,768 oz., equal to 9·5 dwt. per ton. The revenue from the sale of gold was £2,247,718, of which £359,583 accrued from the premium. The working cost was £1,080,453, leaving a working profit of £1,167,265. The dividends absorbed £980,000, being at the rate of 70%. Development was curtailed by the strike, but during seven months of active work 975,700 tons averaging 10·7 dwt. per ton was disclosed. The total reserve stands at 8,184,000 tons averaging 8·7 dwt. Sand-filling of the upper levels is to be commenced shortly. A new circular shaft is to be sunk in order to facilitate the development of the south-west corner of the property, and an incline shaft is to be sunk from the bottom of the circular shaft in the middle of the property to the southern boundary.

Modderfontein East.—This company belongs to the Central Mining-Rand Mines group, and was formed in 1917 to acquire a new lease area in the Far East Rand and to amalgamate this with the adjoining Cloverfield and Rand Klip properties. Development has been centred on the new area and the Cloverfield, and is done through No. 1 shaft in the Cloverfield area and Nos. 2 and 3 shafts in the lease area. The ore is still sent to the Apex mill for treatment, as financial conditions have not yet permitted the transfer and re-erection of the purchased Simmer Deep-Jupiter plant. The report for the year ended June 30 last reflects the adverse effect of the strike early in 1922. During the year under review 268,962 tons of ore was raised, and 236,700 tons averaging 8·9 dwt. gold per ton was sent to the stamps. The yield of gold by amalgamation was 43,193 oz., and by cyanide 52,836 oz., making a total of 96,029 oz. or 8·1 dwt. per ton. The revenue from the sale of gold was £478,603, of which about £70,000 accrued from premium. The working cost was £440,918, leaving a working profit of £37,684. The ore reserve is estimated at 1,962,800 tons averaging 7·1 dwt. per ton. The only satisfactory results of development have come from the area round No. 1 shaft in the Cloverfield area, and unfortunately work has been retarded here lately for various reasons. In the lease area the developments have only disclosed ore of low grade and those in the drives in the north-easterly direction are discouraging. It has been necessary to draw on the high-grade reserves in the Cloverfield area in order to meet expenses.

Nourse Mines.—This company belongs to the Central Mining-Rand Mines group and operates a gold-mining property in the central part of the Rand. The ore is not of high grade and the ground is much broken with dykes. The recent strike has naturally had an adverse effect, but the reduction of costs achieved since will be sufficient to enable the mine to make a profit with gold at par. The report for the year ended June 30 last shows that 433,071 tons of ore was raised, and that, after the removal of waste, 429,650 tons averaging 6·83 dwt. gold per ton was sent to the stamps. The yield of gold by amalgamation was 89,202 oz., and by cyanide 51,464 oz., making a total of 140,666 oz. The revenue from the sale of gold was £699,788, of which £109,799 accrued from premium. The working cost was £677,412, leaving a working profit of £22,376. The ore reserves were fully maintained, and stand at 1,650,260 tons, averaging 6·9 dwt. per ton.

Consolidated Main Reef.—This company was formed in 1896 as a consolidation of other companies that had operated in the middle-west Rand since 1888 and 1893 respectively. The control was for many years with the Neumanns, and is now with the Central Mining-Rand Mines group. In 1918 the adjoining Main Reef West property was absorbed. The report for the year ended June 30 last shows that 525,146 tons of ore was raised, and that, after the removal of 11% waste, 466,470 tons averaging 7·67 dwt. gold per ton was sent to the stamps. The yield of gold by amalgamation was 123,689 oz., and by cyanide 46,499 oz., making a total of 170,188 oz., or 7·3 dwt. per ton. The revenue from the sale of gold was £847,902, of which £133,777 accrued from the premium. The working cost was £777,326, leaving a working profit of £70,576. A dividend of 5% was paid last December, absorbing £62,380. The strike early this year reduced the output and profit, as was to be expected. The ore reserve is estimated at 1,141,900 tons averaging 7·3 dwt. per ton, all of which is in the Main Reef Leader. As the ore available to No. 2 shaft is nearing exhaustion, it is likely that the tonnage milled will decrease by the end of the company's current year.

Otavi Mines.—This company, with headquarters in Berlin, has worked lead-copper ores in South-West Africa since 1900. The report for the year

ended March 31 last shows that 36,820 tons of ore was shipped, averaging 13·5% copper, 29·3% lead, and 10·4 oz. silver per ton; that 55,500 tons gave 33,600 tons of concentrate, assay not specified; and that the smelter treated 24,000 tons of ore averaging 6·5% copper and 8·4% lead, yielding 2,894 tons of copper matte averaging 49·3% copper, 20·3% lead, and 27 oz. silver, together with 450 tons of lead containing 51 oz. silver per ton. The ore was raised chiefly from the 6th to 8th levels. Developments have been resumed, and a new shaft is being sunk. It is notable that, after passing through a sulphide zone, carbonate ores are now being found again in depth, and that lately zinc compounds have formed an increasing proportion of the ores developed. The extensions of the concentration plant are nearly completed, and in the future large amounts of low-grade ore will be treated. The profit for the year was £43,657, out of which £40,000 is being distributed as dividend, being at the rate of 5%.

Mount Morgan Gold. — This company has operated the famous gold-copper deposit near Rockhampton, Queensland, since 1886. The report now issued covers the year ended May 28, 1922. The mine and smelter were idle from April 17, 1921, to March 13, 1922, owing to low prices and high wages, and a resumption was only made possible by a reduction of wages and railway charges. Since then operations have been hampered by a shortage of skilled machine miners. The amount of ore raised during the period covered by the report was 49,758 tons, of which 15,107 tons was sent to the smelter and 34,651 tons to the concentrating plant. The smelting ore was calculated to yield 3% copper and 6·14 oz. gold per ton. At the concentrators 34,135 tons of ore was treated, averaging 2·03% copper and 6·03 dwt. gold per ton. The total concentrates from jigs, tables, and flotation plant were 11,771 tons, averaging 5·4% copper and 12·98 dwt. gold. At the smelter 27,038 tons of ore and concentrates was treated, yielding blister containing 1,074 tons of copper and 12,492 oz. gold. The development of the coal deposits at Dawson Valley has been continued, and coal is now being delivered to Mount Morgan; a considerable reduction in costs is expected to ensue from the use of this coal. The accounts for the year show credits of £254,841 for blister copper containing gold. A large proportion of the revenue came from the realization of copper unsold at time that operations were suspended in April, 1921. The year terminated with an adverse balance of £25,102.

Consolidated Gold Fields of New Zealand.— This company was formed in 1896 to acquire from the late David Ziman certain gold-mining properties in the Reefton district of New Zealand. The company floated off the Progress and Blackwater properties as separate companies, and continued to work the Wealth of Nations mine itself. Mining operations at the Wealth of Nations mine were suspended in 1918 owing to a fire. The report for 1921 shows that repairs at the Wealth of Nations mine have been continued, but that as adequate funds for this purpose are not available, negotiations have been commenced for the disposal of the property to a local company. **Progress Mines.**— Operations at this mine were suspended in 1920, owing to the exhaustion of reserves. The New Zealand Government has offered a grant of £10,000 for the purpose of reopening the mine, provided the shareholders subscribe a similar sum. This proposal is now under consideration. **Blackwater Mines.**— The report for 1921 shows that 34,323 tons of ore was raised, averaging 8·84 dwt. per ton, and that gold selling for £66,829 was extracted, at a working cost of £57,903, in addition to which £7,566 was spent on capital account out of revenue. The ore reserve is calculated at 95,180 tons averaging 9·55 dwt., an increase in tonnage and content as compared with the previous year. A supply of water-power is being introduced, so that there should shortly be a reduction in the power bill.

Siamese Tin.—This company was formed in 1906 ro acquire alluvial tin properties at Ngow, Renong district, Western Siamese States. A dredge was put to work in 1912 and two others in 1914. H. G. Scott is the general manager, and A. N. Wakefield is resident manager. The report for 1921 shows that the three dredges treated 2,442,500 cu. yd. of ground for a yield of 1,299 tons of tin concentrate. The revenue from the sale of concentrate was £140,619, and the net profit was £25,125, out of which £18,000 has been distributed as dividend, being at the rate of 15%. The output of tin concentrate was the highest on record, being 361 tons more than in 1920, the previous highest year. This increase is due chiefly to No. 3 dredge being in exceptionally rich ground. The total yardage has also being increased owing largely to No. 2 dredge being equipped with a chain of close-connected buckets. Boring has been continued on the Plaiwah ground, but prospecting generally has been restricted for financial reasons.

Pena Copper Mines.—This company has worked pyrites mines in the Province of Huelva, Spain, since 1900, acquiring the properties from a Belgian company. Small dividends were paid for the years 1903–6, 1915, and 1916. The report for the year 1921 shows that 96,651 tons of ore was raised, of which 66,083 tons was sent to the leaching floors, and 30,568 tons was prepared for export. The amount of fine copper produced by precipitation was 578 tons. The shipments included 30 tons of cupreous ore, 81,083 tons of washed pyrites, and 22,533 tons of non-cupreous ore, total 103,646 tons. The net profit for the year was £4,962, which was carried forward.

Buena Tierra.—This company was formed in 1912 by the Exploration Co. to acquire silver-lead deposits in the Santa Eulalia district, Chihuahua, Mexico. In the report of the Exploration Co., published in March of this year, it was stated that the mine was closed down owing to low grade, high costs, and poor results of development. The report of the Buena Tierra Co. and the speech of the chairman at the meeting show that the position has improved and that the company has re-started operations. After the closing of the mine on July 1, 1921, W. S. Dwelly worked the property on lease at a profit. The company subsequently appointed J. C. Pickering as consulting engineer, who, with R. N. Hunt, made an examination of the property. As a result of favourable reports received as a result of the examination the company terminated the lease and resumed operations on its own account on July 1, 1922, retaining Mr. Dwelly as manager. The July output is reported at 1,134 tons, of which 548 tons has been sold to the smelters, averaging 9·2% lead and 33 oz. silver per ton. During the year 1921 covered by the present report the sales of ore brought an income of £2,225, and there was an adverse balance of £17,853.

The Mining Magazine

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EDITORIAL

THE gold medal of the Institution of Mining and Metallurgy is awarded this year to Sir Alfred Keogh "on the occasion of his retirement from the rectorship of the Imperial College of Science and Technology, in recognition of his great services in the advancement of technological education, and as a mark of admiration and respect." The gold medal of the Institution of Mining Engineers is given to Sir George Beilby, "in recognition of his valuable contributions to science, with special reference to his researches on fuel." These medals will be presented at the dinner of the two institutions to be held in the Guildhall on the 16th inst.

WHILE writing of medals, it is of interest to record that the American Institute of Mining and Metallurgical Engineers is taking steps to found a James Douglas Gold Medal, to be awarded annually for achievement in non-ferrous metallurgy. The gift of the necessary funds is anonymous at present, but the donors may be encouraged to let their names be known, for publicity in these matters is always helpful in other directions. The medal will no doubt rank with the John Fritz medal, which was founded in memory of the great steel metallurgist. James Douglas was twice president of the American Institute, and was recipient of the John Fritz medal and the gold medal of the Institution of Mining and Metallurgy. The first award of he new medal will be announced at the annual banquet of the Institute in February next.

THE sudden collapse of the Lloyd George Cabinet, owing to the withdrawal of support of a large number of Conservatives, has brought into existence a new government headed by Mr. Bonar Law. A general election is taking place on our day of issue, and as no one is venturesome enough to predict the result of this appeal to the country, it is useless to analyse the political prospects on this occasion. Suffice it to say that while the immeasurable value of Mr. Lloyd George's services to the country during the war are not forgotten, there is a widespread feeling that the present condition of affairs demands control by someone of less enthusiastic temperament and with a deeper knowledge of finance and industry. It is notable that Mr. Bonar Law has chosen as members of his Cabinet several men who have direct personal knowledge of our Overseas Dominions. Lord Curzon is well acquainted with India and the Mohammedan races, the Duke of Devonshire was Governor General of Canada, Lord Novar held a similar position in Australia, while Viscount Cave, the new Lord Chancellor, spent many months in South Africa studying the Rhodesian financial and land-tenure problems in connection with the claims of the British South Africa Company. So it may be said that Mr. Bonar Law's policy is peace, retrenchment, and consolidation of the Empire.

ON another page Mr. Herbert K. Scott contributes to the discussion relating to the ore reserves of the world, and voices the necessity for greater care in the classification of known deposits of iron ore. In the last issue we commented on this subject in connection with the reports on iron-ore reserves prepared by the Imperial Mineral Resources Bureau. Mr. Scott would go further than we did, and would refuse to include as reserves any deposits which are not mined now and are not likely to be workable under present conditions. His contention is a sound one from the business man's point of view, but the mining geologist may protest against no mention being made in the estimates of immense deposits which may be of commercial value at some future time. The difficulty arising from this difference of opinion might be avoided by restricting the word "reserves" in the way Mr. Scott indicates, and by forming a new class for deposits deserving mention but of no present value. Into this category a large number of the known occurrences of the world would fall. A disadvantage of such a classification would arise from the necessity for explaining the various reasons for the inclusion of deposits in this category. For instance, it would have to be said that there are deposits in iron-smelting centres which though vast are of too low a grade and too expensive to work; that rich deposits in many parts of the world have deficient rail transport to the coast; and that other deposits are not available to those who covet them on account of political and racial reasons. Such explanatory classifications would be

clumsy and often invidious, and would give rise to some acrimony when the subject is discussed by the committees of consultation. Perhaps the matter may be left by saying that Mr. Scott has done good service in urging that in the drawing up of all reports of this character the commercial element should take a leading part in assessing the value of an iron deposit.

Russo-Asiatic Consolidated

Perhaps nobody has made a more gallant attempt to bring the present leaders in Russia to their senses than Mr. Leslie Urquhart, the chairman of Russo-Asiatic Consolidated. He has conducted two lengthy series of negotiations with M. Krassin, the Soviet's representative, the first during 1921, and the second during most of the current year. In November last we gave an outline of the terms offered by the Government in 1921 to Russo-Asiatic Consolidated in connexion with the reopening of the company's mines, and we showed how the principles of political economy laid down by those in power made it utterly impossible for the company to resume business relations in Russia. Shortly afterwards it was announced that Mr. Urquhart had been asked to confer once more with M. Krassin, and this was taken as a sign of some return toward sanity on the part of the Russian authorities. The outcome of these further negotiations was even more encouraging, but subsequently the Soviet refused to confirm M. Krassin's agreement, for political reasons solely. At the time of writing negotiations are still proceeding, and we believe that there will be a turn in the course of events before long, and that different conditions will arise in the near future.

The terms forming the basis of the Krassin-Urquhart agreement of 1922 were surprisingly reasonable. They provided for the return of the Kyshtim, Tanalyk, Ridder, Ekibastus, and the Steppe properties on a 99 years' concession, and the financial assistance of the Government to the extent of 20,000,000 gold roubles ; it was agreed that the company should be free to engage and discharge workpeople and employees, and that workmen's committees would not interfere in any way in the administration or operations of the properties ; the royalty and taxation was to be limited to 8% of the gross sales, and the company would guarantee a specified minimum production ; there were also a number of provisions to safeguard the agreement and for the settlement of any disputes that might arise. All these conditions and stipulations were acceptable to Mr. Urquhart, and they were taken as an augury for better times in Russia. The fact that the refusal to ratify was not based on any objection on the part of the Soviet to the terms of the agreement confirms this cheerful augury.

The reason for refusing confirmation is that, though the Russian Government is desirous of helping the Russo-Asiatic, it cannot enter into any agreement with an English company until the British Government recognizes the Soviet Government and Russia is given a voice in the settlement of the Eastern question. This attitude was adopted as a political move, and most people will grant Russia the right to take such an attitude. Some degree of recognition has already eventuated, for Russian representatives have been invited to the Near East conference to be held at Lausanne. If Mr. Bonar Law remains in power after the elections, the political and economic atmosphere in Europe will undergo a considerable change and the conditions not only in Russia but in Germany, Austria, and other countries will be examined in detail from a different point of view. Other companies and individuals interested in Russian industries should have backed Mr. Urquhart in the past and it is not too late for them to do so now. It is generally felt that the revival of agriculture and iron and coal mining is of more importance to Russia than a resumption of copper production and the development of lead and zinc properties, and support from those interested in those industries would have greatly strengthened Mr. Urquhart's hands. But we have reason to believe that the Soviet have already recognized the necessity for the participation of the business man in the restoration of all Russia's industries, and that with a little encouragement from outside Governments this restoration will be greatly facilitated.

The Dolcoath Scheme

In the October issue reference was made to the financial support offered by the Government to Dolcoath in connexion with the reopening of the Roskear properties to the north of the main mine, and details were given as to the nature of the development campaign involved. Since then the

directors have called shareholders together and have placed before them the scheme whereby the company will raise the additional capital required under the Government stipulations. As already recorded, the Government is willing to guarantee a loan of £50,000 provided the company contributes £70,000, the total £120,000 representing the funds required to bring the new venture to a productive stage. The Government asks for a first charge on the company's assets, so not only has the company to provide additional funds but it must also remove the present first charge vested in the debentures and the priority shareholders. At the present time the ordinary share capital is £350,000 in £1 shares, and there are an equal number of priority shares of 1s. each, the latter having been issued a year and a half ago for the purpose of meeting demands of creditors and keeping the property intact. The debentures, amounting to £75,000, were issued in 1918 for the purpose of purchasing the mineral rights, the company then receiving 40,000 shares in Tehidy Minerals, Ltd. Under the present scheme of reconstruction a new company is to be formed with a capital of £250,000 divided into 500,000 shares of 10s. each. Of these shares, 350,000 are to be offered to present shareholders, credited with 5s. paid, so that if all the shares are taken up the sum subscribed will be £87,500. As regards the present debentures, holders are offered 100,000 shares in the new company issued as fully paid, and 6,750 shares for interest due, together with 37,500 Tehidy Minerals shares of £1 each. The priority shareholders are offered two new shares fully paid in exchange for twenty 1s. shares. The directors have not drawn fees lately, and they agree to take payment in shares of the new company. It has been far from easy to frame a scheme of this sort owing to the uncertainty as to the present market value of the debentures and the various shares involved ; but the scheme seems equitable, and Mr. F. A. Robinson, the deputy chairman, is to be congratulated on being its author. There are one or two points in connexion with it that are of interest. The calls on the new shares will be spread over two years, so that holders will not be unduly stressed. As each call of 1s. is made up to £50,000 an equal amount will be raised under the Government guarantee. With regard to the shares in Tehidy Minerals, it is to be noted that these are not included in the assets on which the Government will hold a lien. These shares are of considerable prospective value, for Tehidy Minerals, Ltd., owns the mining rights of the Tehidy and Lanhydrock estates and is interested in china-clay operations as well as tin mining. Finally, it must be mentioned that the dealings between the directors and the Advisory Committee under the Trade Facilities Act were always of the pleasantest. On this Committee were such well-known City men as Sir Robert Kindersley and Sir William Plender, while Mr. Frank Merricks acted as their mining advisor, and it may be assumed that their business judgment is shrewd and sound.

As we have said, Mr. Frank Merricks reported on the proposal to the Advisory Committee. He made a thorough examination of the facts and records on which the project is based and presented a report. His report is accessible and extracts have been circulated by the directors. He confirms the views of Mr. R. Arthur Thomas and of Messrs. Bewick, Moreing & Co., to which reference was made last month, with regard to the past history of the North and South Roskear workings and the reasons for their abandonment in 1874 and 1881 respectively. He points out that great economies can be effected to-day by developing the lodes at depth from one vertical shaft, as compared with the methods and means available in earlier days, when development was never much ahead of the mill. In addition, the arsenic contents will now be an asset instead of being merely a deleterious constituent of the ore. Mr. Merricks proceeds to outline the plan of development. The new vertical shaft is to be sunk to a depth of 1,800 ft., and the cost of sinking and equipment with winding and pumping plants is estimated at £75,000. The remainder of the money, £45,000, will be available for development. The site is near a railway siding of the Great Western Railway which can be easily connected with the Dolcoath private line, so that the ore will be readily delivered from the shaft to the concentration plant. The Dolcoath mine is, of course, well equipped with crushing and dressing appliances and no new expenditure will be required in this connexion. In the course of sinking the shaft, it will be advisable to tap the water in the South Roskear workings and to connect with them for ventilation purposes.

Later it will also be necessary to get under the old North Roskear mine and to develop the lode at the depth of the bottom of the shaft. It is believed that the Rogers, formerly known as the Longclose, lode will be found between the North and South Roskear lodes at the level of the bottom of the shaft; in fact it is expected that the shaft will actually intersect the lode at the bottom. Mr. Merricks mentions that richer ore may be found as the workings proceed eastward toward the Great Cross-Course, which runs north and south through the eastern portion of the property. Some of the richest ore in the old Dolcoath workings was found in this position, and there is good reason for supposing that the same enrichment will be found in the northern lodes. As regards the time that will elapse before production will start, two years is given for shaft-sinking, and another half-year for development.

The above is a brief outline of the scheme now before shareholders. Financially and technically it appears sound. It is not within the functions of the MAGAZINE to recommend particular investments and speculations, but we may be permitted, from the point of view of general Cornish interests, to express a hope that the scheme will go through.

The New Mines Department Report

By the Mining Industry Act of 1920 the whole of the Government functions in connexion with mining were collected under one department, which was constituted a branch of the Board of Trade, and the responsible minister of this department was made Secretary for Mines. This rearrangement not only abolished a confusing distribution of duties, but paved the way for an extension of Government interests in mining. These changes are reflected in the first annual report of the Secretary for Mines, for the year ended December 31, 1921. This report, which was issued at the end of last month, consists, as to 40 pages, of the Secretary's report and, as to 110 pages, of the report of the Chief Inspector of Mines. The Secretary's report contains a general review of mining conditions during 1921. A large part of it is concerned with an account of the coal strike and its results, and with a discussion of the disadvantages of Government control in peace times. The trade conditions governing the output and prices of metalliferous minerals, and minerals used in the chemical industries and in engineering works, are also briefly described, and an account is given of mining for oil-shales and boring for oil. Another section of the report deals with questions of health and safety in the mining and quarrying industries. The report generally, though brief, is concise and interesting.

The report of the Chief Inspector of Mines follows much the same lines as those to which we have been accustomed during the last dozen or so years, but the matter is consolidated and rearranged. Hitherto the report was issued in three separate sections relating to divisional statistics, labour, and output respectively. These are now embodied in the single report. The great folio sheets with the big type and big white spaces have been abolished, and the octavo size with clear type and compact tables is substituted. There are, in addition to this report, other yearly Government publications relating to mining operations in this country, and these are being continued without noticeable modification. We refer to the reports of the inspectors of mines in the several divisions, the list of operating mines, and the list of abandoned mines.

Though the reports are excellent in many ways, particularly with regard to the information relating to accidents and health conditions, they still leave the mining statistician dissatisfied, owing to the absence of specific details of the output. The old custom of giving figures for the production of individual mines has not been revived, and the present classification by counties does not help. What the mining engineer wants is grouping by mineral district rather than political division. For instance, the Leadhills lead-mining district is split between two counties, Lanark and Dumfries, owing to the county boundary passing between two adjoining mines. Similarly, the mining industry of the English Lake District is divided between Cumberland, Westmorland, and Lancashire, and few people know where the boundaries lie. The chief inspectors' reports on output in Le Neve Foster's days were of absorbing interest to the mining man owing to the wealth of detail. Perhaps some day reversion may be made to the system then adopted. It is to be hoped, also, that eventually the Secretary for Mines will arrange for an earlier appearance of these reports.

REVIEW OF MINING

Introductory. — Politics have loomed large in the business world during the past month, and new trade ventures are generally suspended until the result of the elections is known. The Turkish problem continues to cause anxiety, and severe depreciation of the mark is bringing to a head the consideration of the possibility of establishing new currencies in Germany, Austria, and Russia. In the metal markets, tin and zinc have been strong, but the prices of lead, copper, and silver have been uncertain. As regards tin, part of the advance is due to a revival of buying in this country and the United States, and partly to metal market operations; as mentioned in our August issue, there is a strong party bent on pushing up prices.

Transvaal.—The quarterly reports of the gold-mining companies for the period ended September 30 show that an average reduction in the costs per ton of 5s. has been effected since the strike early this year. Instances of these reductions may be given by comparing the figures for the month of September with those for the year 1921. During September the estimated cost per ton at Crown Mines was 19s. 10d. as compared with 25s. during 1921; at East Rand Proprietary 20s. 11d., as compared with 26s. 8d.; at Geduld 19s. 4d., as compared with 23s. 7d.; at Government Mines 17s. 5d., as compared with 21s. 7d.; at Springs 22s. 7d., as compared with 29s. 8d.

The Consolidated Mines Selection Co. has made an arrangement with the Anglo-American Corporation of South Africa, whereby the latter takes over all the former's South African assets, in return for a cash payment of £212,046 and 524,425 shares in the Corporation. These two companies are under the same control, as also is the company with allied objects, the Rand Selection Corporation; the three have similar interests in South Africa, and have large holdings mutually and in the Brakpan, Springs, West Springs, Consolidated Diamonds, and other properties. That there should be three parent companies is, of course, due to the exigencies of finance and to the problems placed before the group. At the present time it is more convenient for the many interests to be held direct by the Anglo-American; 90% of the shares in the Rand Selection have been owned by the Anglo-American since 1920, and the present rearrangement with Consolidated Mines Selection will have a similar effect though by a different method. The group has certain commitments for the provision of capital in the future, and has many opportunities for placing further capital to advantage. Such operations will be better carried out by Anglo-American, especially as Consolidated Mines Selection has been hit hard by depreciation of assets lately. As regards the latter point, the rearrangement will place Consolidated Mines Selection in a better financial position, and a resumption of dividends from its holding in Anglo-American will be possible at a much earlier date than it would otherwise be. Some readers may think that the control of this group has now passed to the American capitalists who supplied some of the funds for the Anglo-American; we are informed, however, that this is not the case, and that the American shareholders are in a considerable minority.

As recorded in our August issue developments at West Springs are now giving such satisfactory results that the provision of a metallurgical plant has been under consideration for some months. It is now announced by the directors that the engineers have commenced the design of an all-sliming plant. The last quarterly development report, for the period ended September 30, states that 3,912 ft. was on reef, the average assay being 7·94 dwt. over 38 in.; of this footage, 2,100 ft. or 53% of the whole is payable, averaging 12¼ dwt. over 37 in.

The General Mining and Finance Corporation, the parent company of the Albu group, has purchased the whole of the ex-enemy holdings, amounting to 800,000 £1 shares, at a price of 2s. each. These shares will be cancelled, and the nominal capital, £1,875,000, reduced to £1,075,000. It will also be possible to utilize the difference, £720,000, between the nominal value of the shares and the price paid in writing down the book value of the company's investments. This rearrangement will have a healthy effect on the company's financial position. The company has also purchased all the ex-enemy shares in the subsidiary mining companies of the group.

Knight Central is to be closed at the end of January, when the reserve of payable ore will be exhausted. During the last few years a stoppage has been contemplated

several times, but during recent months the improbability of finding further ore has been accentuated. The position was fully stated in the annual report quoted in our issue of May last.

It is stated that an arrangement for amalgamation has been made by the Union Steel Corporation, of Vereeniging, and the South African Iron and Steel Corporation, of Pretoria; also that an interest is to be taken by an English steel company. Each of these companies erected a blast-furnace in 1918. The iron-ore deposits of South Africa were described in the MAGAZINE for October.

Diamonds.—Some surprise has been caused by the intention of the board of De Beers Consolidated to create 100,000 additional deferred shares of £2 10s. par value. The purpose for which this additional capital is required has not been announced, and it is not known whether the new shares are to be sold for cash, used for the purpose of acquiring other property or shares, or merely held in reserve. It is hardly likely that further working funds are required. One of the surmises is that the outstanding Premier shares not yet owned by De Beers are to be acquired.

Rhodesia.—The output of gold during September was reported at 55,443 oz. as compared with 56,037 oz. in August and 52,436 oz. in September, 1921. Other outputs for Southern Rhodesia were: Silver, 14,393 oz.; coal, 46,070 tons; chrome ore, 20,495 tons; copper, 288 tons; asbestos, 1,558 tons; arsenic, 17 tons; mica, 5 tons; tin, 1 ton; diamonds, 46 carats.

The result of the referendum in Rhodesia on the question of future government is that absorption by the Union of South Africa is rejected and self-government chosen. The numbers voting for self-government were 8,774, and for joining the Union 5,989. The majority was larger than expected, though few believed that the majority would be on the other side. Rhodesia is a large country with a small white population—only 34,000—and the decision to remain independent speaks volumes for the pluck of the community in determining to shoulder the formidable burden of government.

Australia.—The cabled report of the Electrolytic Zinc Co. covering the year to the end of June announces that during the seven months that the plant was in operation from the start at the end of November, 1921, 11,550 tons of zinc was produced, together with residues containing 1,492 tons of lead and 283,290 oz. silver. These residues are sent to Port Pirie for treatment in the lead blast-furnaces. The construction of the plant is nearing completion, and the full horse-power required, 30,000, will be available with the new year; the output of zinc will then be increased to 120 tons per day. Additional furnaces for roasting the concentrates are being built at Port Pirie, and an arrangement has been made with the Sulphide Corporation whereby the latter will roast 30,000 tons a year at Cockle Creek. The company has secured markets for its zinc in Eastern countries in competition with well-known brands from Europe and America.

It is stated that a new scheme is under consideration for the provision of capital for the Mount Elliott company, for the purpose of erecting metallurgical plant recommended by Mr. W. H. Corbould, the general manager. The control of this company is with French shareholders, and there have been difficulties arising from exchange that have caused previous proposals in this direction to fall to the ground. No details of the new plan are as yet available for publication. The process recommended by Mr. Corbould was described in the MAGAZINE for December, 1921.

Last June we recorded that Hampton Properties had decided to erect a metallurgical plant with a capacity of 1,000 tons per month to treat the ore from Block 45. This plant will be ready by he end of the year. The developments since have been so satisfactory that an extension of the plant is already contemplated. As the oxidized ore has been opened out on the 100 ft. level its width and content are found to be greater than expected. The width of the lode varies from 7 to 12 ft., and the assays range from 9 to $12\frac{3}{4}$ dwt. gold per ton.

New Zealand.—The Onakaka Iron and Steel Co. has had a trial run of the blast-furnace erected at Onakaka to treat the Golden Bay deposit of iron ore. The result has been so satisfactory that the company is proceeding to erect coke-ovens. Conditions here are promising, for iron ore, coal, and limestone are all near at hand and the deposits are owned by the company. Particulars of these iron-ore occurrences are given in the Mining Digest this month.

India.—The North Anantapur gold mine was closed last July and the cyanide treatment of dump material is expected to come

to an end in January. The company is continuing development on the Sideshur copper property in Chota Nagpur, on which it has an option. It has placed capital with the Anglo-Canadian Explorers, Ltd., and with the Continental and General Exploration Co., Ltd., the latter of which has gold-mining interests in Sumatra. More recently attention has been turned to some ancient gold workings about 35 miles from Anantapur, and prospecting is to be commenced forthwith.

Malaya.—The Tekka-Taiping company announces that the overhaul of the No. 1 dredge is now completed, and that both dredges are operating. The period of low production is therefore at an end.

Cornwall.—Particulars of the Dolcoath scheme for raising capital for the development of the Roskear areas are given elsewhere in this issue.

Operations at Levant are on a gradually increasing scale. During the third quarter of the year 50¾ tons of tin concentrate was won, together with 11½ tons of arsenic soot. For the quarter ended June 30 the output of tin concentrate was 39 tons, and for the first quarter of the year 9½ tons. The new ore-bin and crusher station were put in commission on August 28. The second unit of the new mill is under construction, and should be completed by the end of this month provided there is no delay in delivery of machinery.

The new pump at South Crofty commenced work on November 1, and the mine will probably be unwatered early in the new year.

Canada.—The Le Roi No. 2 Company, operating the Josie and other properties at Rossland, British Columbia, has let its property on option until February 1, 1923. This company was originally formed by the late Whitaker Wright, who floated the property here with an unwarrantably big capital. Subsequently, under the chairmanship of Lord Ernest Hamilton and the management of Alexander Hill and Stewart, the mines did well and dividends were paid. Of recent years the increase in cost of labour and supplies has wiped out any possible margin of profit. A year ago mining was suspended, and subsequent efforts to concentrate dump material and broken ore were not attended by success. The directors therefore decided to sell the property. The present option fixes the purchase price at £30,000.

The utilization of iron-ore deposits in Ontario continue to be discussed by the Government and committees of engineers and commercial men. In the meantime it is announced that C. K. Quinn & Co., an American firm, has taken options on the Atikokan deposits and on deposits on the Mattawin Range. The former deposits are high in sulphur, and the latter are composed of siliceous magnetite. Neither class of ore is particularly attractive to the ironmaster.

Mexico.—Many rumours of rich discoveries at the mine of the Mexico Mines of El Oro have been prevalent recently, and the directors have felt it necessary to publish an official statement as to the real position. Developments on the West vein a year ago at first gave remarkable results, but subsequently the rich ore was proved to be of limited extent and erratic in occurrence. In June of this year another lens of rich shipping ore was discovered on the 11th level. Since then this shoot has been found on the 10th and 12th levels, and its average length is estimated at 45 ft., and its width 8 to 14 in. Owing to the prevalence of ore stealing by armed thieves, it was considered best to extract this rich ore as rapidly as possible. Thus recent returns have been above the average. Rich shoots are characteristic of this mine, and others may still be found. The usual policy is to extract rich and average ore concurrently and any variation has a sound reason.

The Consolidated Gold Fields of South Africa announces that the offer to purchase the control of the Mazapil Copper Co. has been withdrawn owing to the refusal of a majority of shareholders to respond. Particulars of the scheme of consolidation of this property with those of three companies controlled in America were given in our last issue.

Colombia.—The Colombian Mining and Exploration Company, which operates the Marmato gold properties, is proceeding very slowly toward the long-expected making of profits. At the present time the monthly output of ore is about 5,000 tons, the yield per ton about 21s. to 22s., and the cost per ton 24s. to 26s. The engineers are still hopeful of raising the output to 10,000 tons per month, and to reduce the costs. Mr. Norman Jenks, who resigned from the board and from the management two years ago, has rejoined the board as managing director, and his brother, Mr. Shirley Jenks, who used to be chairman, has rejoined the board as deputy chairman.

THE WEST COAST OF NEWFOUNDLAND

By SIR STOPFORD BRUNTON, BART.

The Author describes a geological reconnaissance of a tract of country on the West Coast of Newfoundland, between St. George's and Bonne Bay.

INTRODUCTION. — Newfoundland is a country which, at the present time, is in an undeveloped state from the point of view of economic minerals, although indications of many sorts appear in different localities and give promise of future importance. Little geological information has been published about the country with the exception of Murray's report for the Newfoundland Geological Survey,[1] some notes by Jukes,[2] and some private reports to various companies on mineral claims and prospects. A geological map of the island was compiled by Murray and Howley, and issued by the latter in 1907. This map, considering the difficulty of the field work and the scale on which it was published (1 inch to 8¼ miles), is comparatively accurate, although, as might be expected, the relative age of some of the igneous masses is undetermined and the information given lacks precision in many instances. Howley has also written on the coal deposits.[3]

During the summer of 1912, the writer was enabled, through the courtesy of Sir William Reid, President of the Reid-Newfoundland Railway Company, to do some geological work on the west coast of the island, between St. George's and Bonne Bay. The work commenced at St. George's in June, and was continued until September, covering the localities of Stephensville, Port au Port, St. George's Pond, Fox Island River, Bay of Islands, and Bonne Bay, where various prospects of economic minerals exist in a more or less undeveloped state.

GENERAL GEOLOGY.—The area traversed lies on the western side of the island, in what is apparently the trough of a geosyncline cut off towards the south by an east-west fault. The strata forming this syncline range in age from Cambrian through Ordovician limestone and argillaceous sediments of undetermined age to Carboniferous sandstone. Igneous masses, which will be discussed later, appear among the sediments, as follows: (1) East of St. George's, an anorthosite mass; (2) A mass of hypersthene-monzonite, which forms Indian Head, Bay St. George, and runs inland in a north-easterly direction; (3) Large masses of peridotite, all along the western shore of the island as far as Bonne Bay.

It must be remembered that Mr. Howley's map (see Fig. 2) represents the geology of the island only in a general way, and that the formations were determined by geological age without reference to lithological characteristics. Naturally, therefore, further work may well render alterations and additions necessary without in any way detracting from the value of the original work. In this paper certain new facts which have been brought to light will be

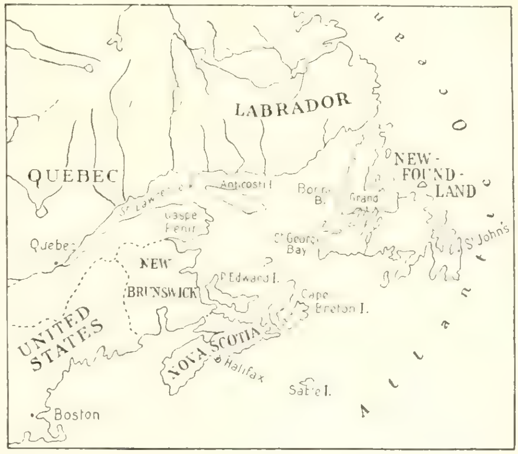


FIG. 1.—MAP SHOWING POSITION OF NEWFOUNDLAND AND ADJACENT PROVINCES.

briefly stated. The map in Fig. 3 illustrates the work done by the author. The map in Fig. 4 gives details of the topography.

The igneous mass east of St. George's is marked upon Howley's map as of Archæan or undetermined age, and its northern limit is not definitely shown but appears to be some distance south of St. George's River (South-West Brook). The work done during 1912 shows that the mass is composed of anorthosite, that it extends as far as Bottom Brook, and that it is probably intruded into the overlying sediments, in which case it must be of Carboniferous or post-Carboniferous age. The fact that the anorthosite extends to Bottom Brook is significant, for, should the direction to the brook be followed

[1] Report of the Geological Survey of Newfoundland, 1870–9.

[2] *Excursions in Newfoundland*, 1839–40.

[3] *Coal Resources of the World*, 1913.

up, Grand Lake, Sandy Lake, and White Bay would be found to lie in the prolongation of its course.

The igneous mass near Stephensville Crossing has been petrographically determined as a hypersthene-monzonite, and is probably intruded into the overlying sediments.

The peridotite mass has been found to be a rock composed of serpentine as a matrix with augite and diallage crystals, which, however, are not phenocrysts and have no definite crystalline boundaries. This determination places the rock in the class of the lherzolites.

Between St. George's and Stephensville Crossing one finds unconsolidated sediments of Cainozoic age. These overlie the Carboniferous strata unconformably, but their exact age has not been definitely ascertained.

With regard to the strata on Shoal Point, the writer's interpretation of their character differs from that indicated on Howley's map. This difference will be clear from an inspection of the two accompanying maps (Figs. 2 and 3). Argillaceous sediments appear on Shoal Point between the Carboniferous sandstone, which forms the end of the point, and the Ordovician limestone, which forms the southern boundary of the bay. The

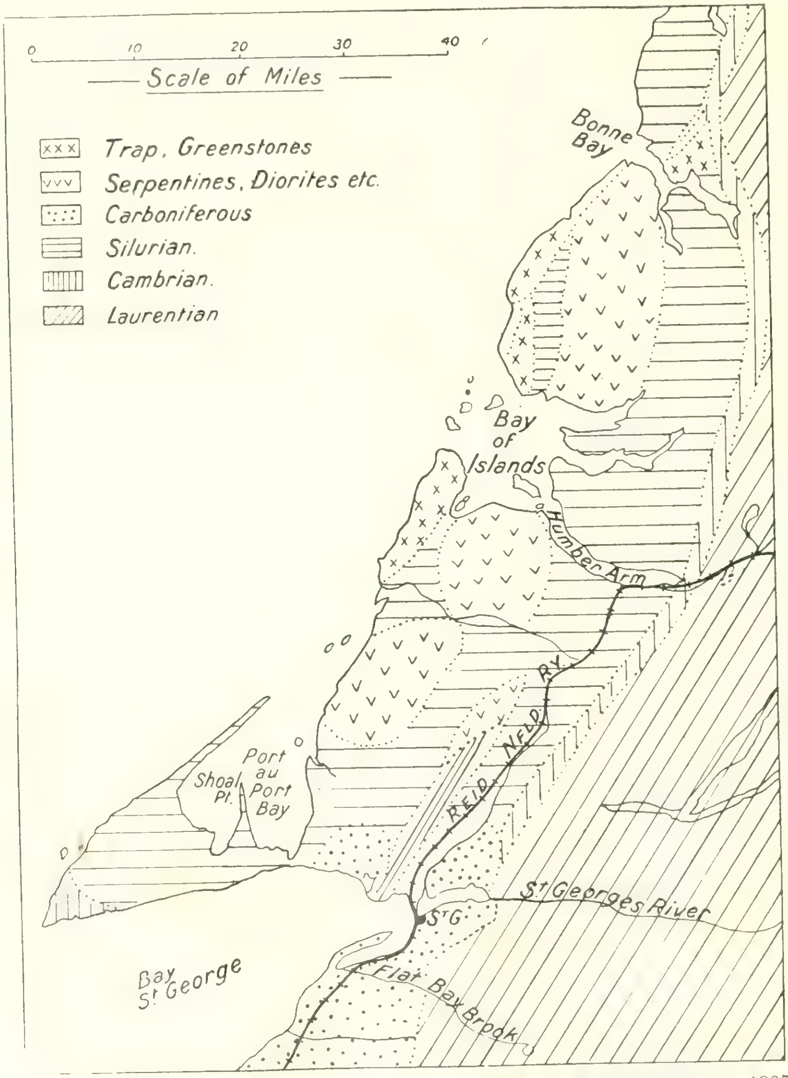


FIG. 2.—MAP DRAWN FROM THE GEOLOGICAL MAP OF NEWFOUNDLAND, 1907.
The strata are indicated according to their supposed geological age without reference to lithological character.

age of these sediments, has, however, not as yet been positively determined.

A study of the strata in Port au Port Bay suggests the probability that the geosyncline has been cut by a fault running in a direction approximately parallel to its axis, and that this fault is the cause of the oil seepages at Shoal Point.

development. Magnetite occurs as a segregation in the hypersthene-monzonite mass about half way between Stephensville crossing and Stephensville. Titaniferous iron ore occurs as small magmatic segregations in the anorthosites east of St. George's. At Port au Port, galena is found in the limestone, but although samples of the ore

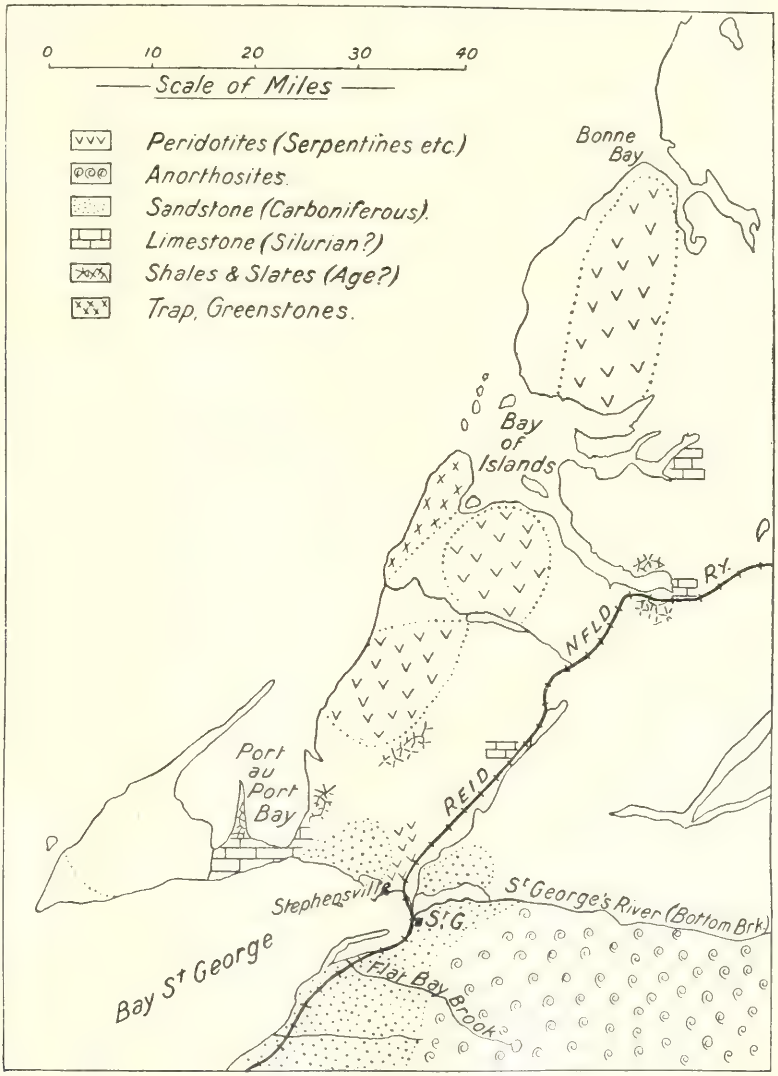


Fig. 3.—Map indicating Rocks as identified lithologically in the field by the Author.

were seen by the writer, no prospect was visited. Oil also occurs here, associated with what is apparently a fault zone traversing Port au Port Bay. The peridotites near Fox Island River contain chromite of good quality, and on the eastern edge of the outlying mass, near Log Cabin, asbestos is found. In other parts of the

Various problems appear from the study of the locality, but the material collected is too meagre for their complete solution, and further work is necessary in the field before certain suggestions made later in this paper can be verified or contradicted.

Of the various economic minerals in this area, some only show promise of future

island ores of nickel, manganese, and molybdenum are known to occur, and deposits of copper, gold, and iron ores are worked on a commercial scale.

FOLDING AND FAULTING.—The western side of the island has the form of a geosyncline basin with a geoanticline ridge to the eastward of it. The folds follow the trend of the continuation of the Appalachian axis. In addition to these there is a series of faults having an east and west trend, and the northern coast of St. George's Bay lies along one of these faults. South-West Brook continues along the fault line and has a straight course. The southern coast-line of the island runs quite straight in an east-west direction, parallel to the direction of South-West Brook. The direction of these faults is again parallel to the southern shore of Chedabacto Bay, Guysboro county, Nova Scotia, which continues along the course of Salmon River and has been shown to be a fault.

It seems as if at least one period of east-west faulting took place after the intrusion of the anorthosite mass, for if the faulting preceded the intrusion, the latter would either have followed the line of weakness made by the fault or it would have healed the fault zone, in which case South-West Brook would have had no factor to render its course so straight. If this faulting took place after the intrusion and the intrusion is post-Carboniferous, then the faulting is also post-Carboniferous. It is known that the faulting in Guysboro county, Nova Scotia, is post-Devonian, as beds of this age are involved; but whether or not it is post-Carboniferous is undetermined, as Carboniferous beds do not appear in the zone of faulting. The probability, however, is that faulting took place at intervals, successive stages even occurring in different geological periods.

PHYSIOGRAPHIC FEATURES. — The area described seems to be a part of the old Cretaceous peneplain which was later, during the Pleistocene period, eroded by the glaciers to the bare rock surface in the same manner as the Laurentian protaxis. South-West Brook and Flat Bay Brook seem to be pre-glacial streams, and their courses were governed by the eastward faulting before mentioned. The deeply indented coast-line, as shown by St. George's Gut, the various arms of Bonne Bay, and Bay of Islands, together with the loose deposits round St. George's Gut, seem to indicate the same coastal submergence as that of the St. Lawrence gulf when the Saxicava sands and Leda clay were deposited.

The flora of this district is very variable. On the low-lying sandstone there are peat bogs, and small growths of timber, large enough for use as pulp wood. Some districts have a superficial covering of soil, and these are the only parts of the island where agriculture is possible to any extent. The anorthosite hills are almost entirely barren except for dwarf laurel and in places stunted growths of juniper. In the district of the limestone belt, the country becomes much more rugged and is very densely wooded, chiefly with fir and spruce; these features, as well as the bearing undergrowth, make travelling here very difficult. The peridotites in most localities are entirely bare of vegetation, except for a few small mosses and lichens.

The age of the igneous masses on the west coast of Newfoundland is in all probability Carboniferous or post-Carboniferous instead of Archæan, and the igneous rocks therefore intrude the sediments of earlier age. The igneous masses of Cape Breton Island and Nova Scotia have been shown to be Carboniferous and those of Gaspe Peninsula at any rate post-Devonian. In other words, the area including Gaspe, Nova Scotia, Cape Breton Island, and Newfoundland is probably the same petrographical province and probably belongs to the Appalachian system rather than to the pre-Cambrian. If this is so, the question arises as to the relative age of the igneous masses in the rest of the island; whether they are not also Carboniferous or at any rate much more recent than was previously supposed.

If the igneous masses are of Archæan age younger sediments would be deposited unconformably upon them, and there would be no special reason for finding mineral deposits. If, however, the igneous rocks are younger than the sediments, as is here suggested, then the conditions in the area become those of contact metamorphism with the accompanying chemical action and mineral deposition.

The finding of iron ore, chromite, asbestos, lead, pyrite, etc., in the comparatively small area in which the work was done, as well as the metamorphic character of the rocks, clearly denotes an intrusive contact, and therefore this area offers a good field for systematic and scientific exploration.

LOCAL GEOLOGY.—Having, in the above

paragraphs, dealt with the general geology, the writer will proceed to the details of local geology.

St. George's. — In the region of St. George's, sandstone, of Carboniferous age (as shown by various plant remains), extends from the shore eastward for a distance of 5 miles to the base of a range of anorthosite hills (Fig. 5.) The sandstone is reddish in colour and rather coarse in texture, with sub-angular pebbles of quartz, averaging approximately 1½ in. in diameter, embedded in it. Some of the outcrops of the Dribble Brook, however, show a material approaching more nearly to conglomerate, with a friable matrix of argillaceous matter and having a greener colour; but these variations seem to be only local and of no wide areal distribution. The beds strike approximately north and south, with a dip of 25° E. They are entirely barren in this region, although seams of coal have been found in them in the districts lying further to the south.

Some beds of gypsum overlie the sandstone in the neighbourhood of the anorthosite hills, but these beds are of poor quality and would probably not be suitable for economic use.

At the northern end of the village of St. George's there is a deposit of loose conglomeratic material which is not mentioned in Mr. Murray's report, nor on Howley's map. From its unconsolidated appearance and the fact that it has not been eroded, it would appear probable that this is of glacial or post-glacial age, although, as no fossils were found in it, the actual age and mode of formation remain somewhat uncertain. The deposit may, however, be tentatively suggested as corresponding to the Saxicava [1] sand found so extensively along the shores of the St. Lawrence gulf. The deposit was seen in place on the shore between St. George's and the mouth of Little Barachois Brook, and the banks of the brook itself are also composed of this material for some distance from its source. Another outcrop appears at the head of St. George's Gut, at the point where Bottom Brook and South-West Brook enter, and the entrance to the gut is formed by low-lying sandbanks and dunes, evidently made from the re-working of this material. Above sea-level the average thickness of the deposit, when seen in the several outcrops examined, is from 50 to 100 ft. The material itself is a medium-coarse sand, but it contains pebbles and small boulders.

The anorthosites themselves, extending for about 100 miles in a north-south, and some 60 miles in an east-west, direction, rise abruptly to a height of from 800 to 1,000 ft. from the sandstone, and are deeply dissected by river gorges running mostly in an east and west direction. The northern extremity of the mass is bounded by Bottom Brook.

From a geological point of view this mass is extremely uniform in composition. It is composed almost entirely of anorthosite, differentiating in places to a hypersthene gabbro, and throughout its entire length titaniferous magnetite has segregated out in pockets varying in size from that of a walnut or less to masses of some tons, but these pockets are widely scattered. The ore itself appears in massive form. So far as observed, pyrite is not present, so that the sulphur content is probably low; this statement, however, needs confirmation, as no analysis of the ore was made. The boundary between the ore and the wall-rock is sharply defined in most cases, and does not appear to grade out into lean ore. Although careful search was made, only two other kinds of rock were found: firstly, on the top of Cairn Mountain, a series of dykes, which (by microscopic examination) are found to be diabasic in character; and secondly, a dyke some miles in from the edge of the mass, having the composition of a bostonite.

The contact between the anorthosite and the sandstone is hidden in most places, but in South-West Brook, at the upper end of St. George's main gut, the river was cut down to the rock surface, and has exposed a series of rocks which may lead to a determination of the relative ages of the sandstone and the anorthosite. Near the contact is found a rock which upon microscopic examination shows all the characteristics of an argillaceous sediment that has been subjected to contact metamorphic agencies; while, in a thin section from a specimen taken near by, the biotite crystals in the anorthosite show a parallel arrangement giving rise to a gneiss-like structure.

A study of one locality and so small a number of specimens does not justify a positive statement at the present time

[1] *Geological Survey of Canada*, New Series, vol. xv, 1902–3, AA., p. 162; *Geological Survey of Canada*, New Series, vol. x, 1897, J., pp. 67–9; *Geology of Canada*, 1864, pp. 915–18.

that the mass is intrusive into the Carboniferous sediments, but the facts brought to light in the present study point to this conclusion. Also more recent work by Dr. Alcock has shown the intrusives in the Gaspe Peninsula, Quebec, to be Devonian, and the gneiss rocks of northern Nova Scotia are Devonian or post-Devonian.

The above facts would point to the conclusion that the mass was intrusive into the sediments, and that it is therefore post-Devonian or possibly post-Carboniferous in age. This would account for the abnormal dip of the sandstone (which dips towards the anorthosite instead of away from it, as would be the case in a normal unconformity). This evidence, however, is by no means conclusive, and a detailed study would have to be made in the field to verify or contradict the suggestion made above regarding the age of the anorthosite mass.

The hills are sparsely covered with vegetation, only a small thickness of peat lying on top of the rock, and in places the surface is entirely bare.

Stephensville Crossing. — The next locality visited was that between Stephensville Crossing and Stephensville. Here occurs a mass of hypersthene-monzonite, at the edge of which there appears to be a segregation of magnetite in a locality covered with small timber and undergrowth. An analysis shows it to be high in iron, low in sulphur and phosphorus, with traces of titanium and manganese; on the whole a very good ore for development if found to continue in depth. The ore-body appears to be a lenticular mass of the same type as those found in the Adirondacks [1]; such masses are irregular in shape and may either pinch out quickly or continue in a large body to considerable depth.

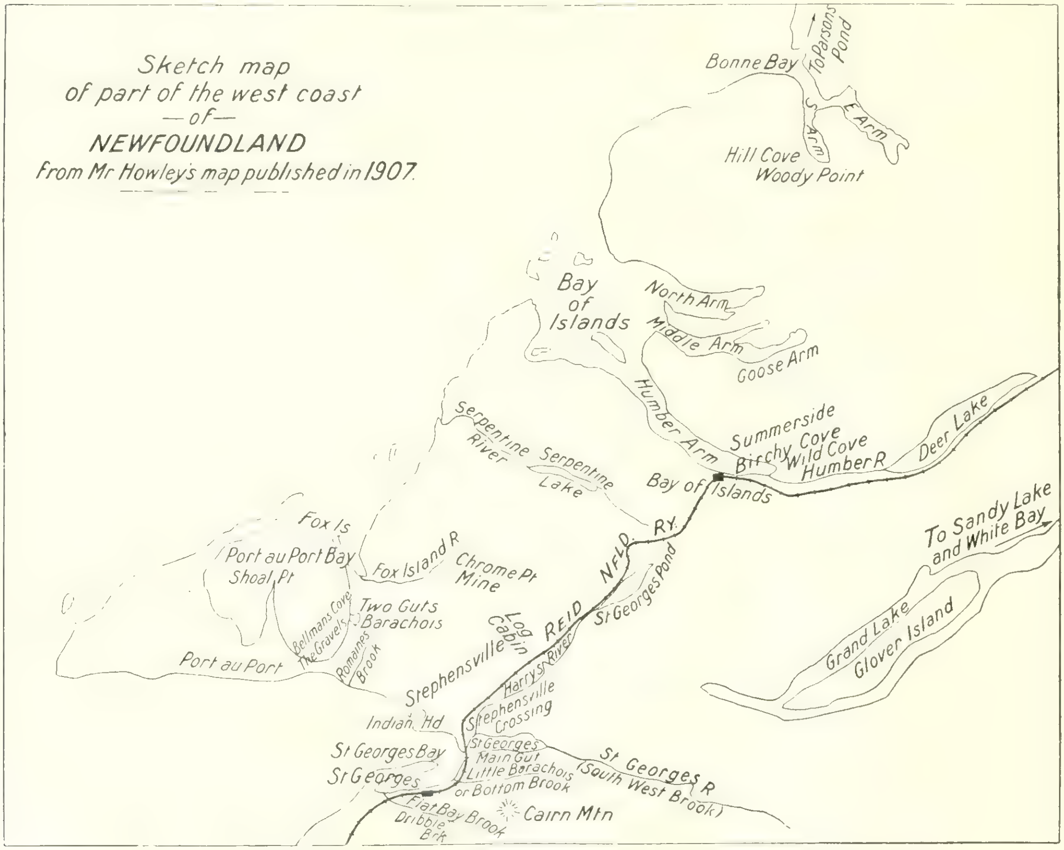


Fig. 4.—Enlarged Map showing Topography of the District described.

The monzonite itself forms a ridge (which runs out into St. George's Bay and forms Indian Head) and is some 350 to 400 ft. high

[1] *New York State Museum Bull.*, No. 119.

at the point, six miles west of Stephensville Crossing, where the road passes over it before descending to another strip of Carboniferous sandstone of the same type as that which occurs at St. George's. On the strip there also occur gypsum beds like those near Cairn Mountain.

Port au Port.—Travelling west to Port au Port, the Carboniferous deposits give place to Ordovician limestone. This limestone forms ridges from 900 to 1,200 ft. high on the eastern side of Port au Port Bay, while on the southern side of the bay the elevation is much less (some 300 to 400 ft.).

On the eastern side of Port au Port Bay, at Two Guts Barachois, the Carboniferous sandstone is again found, dipping at 27° E.; but in this locality it is very highly oil-bearing (Fig. 6). South of this, at a distance of approximately a mile, argillaceous sediments are found lying between the Ordovician limestone and the sandstone, and apparently corresponding to the red and green shales of Shoal Point which are referred to later. These relationships would tend to show that Port au Port Bay lies in a pitching synclinal basin, but the abnormal dip of the sandstone offers a grave objection to the

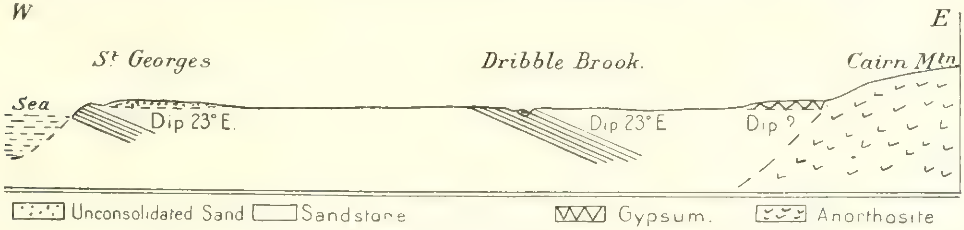


FIG. 5.—DIAGRAMMATIC SECTION OF COUNTRY EAST OF ST. GEORGE'S.

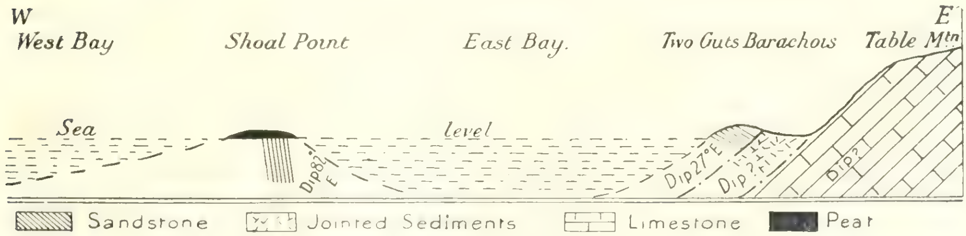


FIG. 6.—DIAGRAMMATIC SECTION THROUGH PORT AU PORT BAY.

The limestone strikes approximately N. 65° W. and dips 12° to the east, and is to all appearances not much disturbed by folding; but in Lead Cove a vein of pyrite, varying in width from a few inches to two feet, occurs. It appears on the surface on the eastern side of the cove as a gossan cap, and it seems to have been prospected without success. The limestone is practically unfossiliferous, although a few *Maclureas* have been found.

The Dominion Iron and Steel Co. invested half a million dollars in a quarry located in Bellman's Cove, at Port au Port, for the production of limestone to be used in their furnaces at Sydney. The limestone is of very good quality, as it shows on analysis 95–97% $CaCO_3$, sometimes replaced in part by $MgCO_3$, with almost no quartz or alumina. The shipping facilities are good, as the cove is protected from almost every direction, and a short pier enables a vessel of considerable draught to come close to the quarry.

assumption that the basin is merely a simple fold. Opposite to this, on Shoal Point, oil-drilling operations have been carried on 20 to 30 years ago, and in 1912 there were some seven drill-holes, in two of which oil was standing at the surface. Shoal Point itself consists of a long, low-lying point of land, covered with a layer of peat from 5 to 15 ft. thick, the surface of which is very wet and spongy. The peat extends to the seashore, stopping short at high-tide level, and thus allowing a few outcrops of the underlying sandstone to be seen, the strata of which here have a strike of N. 10° E. and a dip of 78–82° E. This steep dip rather points to a fault zone, the existence of which is also indicated by the following facts:—

Firstly, a man who was engaged in the first drilling operations said that after descending 590 ft. they found 8 ft. of oil. When, however, they exploded a dynamite devil, all the oil disappeared.

Secondly, in the neighbourhood of Port au Port, there are numerous steep ravines and several coves cut back into the limestone, all running in directions parallel to one another and parallel to the strike of the strata on Shoal Point. The existence of a sudden break in the limestone, at the Gravels (where there is a passage through the rocks which is only closed to navigation by the accumulations of beach gravel that has been washed in by the shore current), would seem to indicate a fault traversing the southern shore of the bay through this point.

Thirdly, in walking from Port au Port to Shoal Point one passes from the limestone to a series of red and green argillaceous sediments which are jointed, so that the rock breaks into small rectangular fragments. Leaving these sediments, one passes to the sandstone.

All these facts seem to point to a fault zone, and it would seem likely that any future drilling for oil would have a better chance of success than at Shoal Point if it were undertaken in the region of Two Guts Barachois, where the dip of the strata is less and the rocks do not seem to have been so much fractured and contorted.

On the western coast of the island large masses of peridotite rocks are to be found. These rocks cover an area some 65 miles long and 20 miles wide, but are divided on the surface into various members, each being a separate unit, although they all probably belong to the same original intrusive mass. This igneous mass is distant from the oil prospect some 10 to 12 miles superficially, but it may very well be in contact with the underlying Ordovician limestone at no very great distance below the sandstone.

It seems that the oil is associated originally with the Ordovician limestone in the same way as it is in the Trenton limestone of Ohio.[1] This idea is supported by the fact that more or less successful oil-drilling is being carried on at Parsons Pond, where, according to Mr. Murray's map, the sediments are Ordovician, though this locality was not visited by the writer and no definite statements can be made from actual observations. These suggestions, however, are put forward merely tentatively, in the light of present knowledge, and their proof or disproof would form an interesting problem for further study.

Another point for consideration is whether or not these masses of anorthosite, hypersthene-monzonite, and peridotite are differentiations from the same magma. At the present time very little exact information is available, but a synopsis of the facts will not be out of place.

(1) The anorthosite mass, from a consideration of the rocks in South-West Brook, is possibly intrusive into the Carboniferous sediments, though this is by no means proved. In the mass itself, hypersthene is found differentiating out, and the felspars are of the andesine variety of plagioclase.

(2) The hypersthene-monzonite is also presumably intrusive in the same sedimentary strata (from a consideration of the ore-bearing zone), its felspar is the same acid variety of plagioclase, and is again associated with hypersthene.

(3) The peridotite masses lie westward from the monzonites, or on the side farthest from the anorthosites, so that a section taken from east to west would show rocks richer and richer in ferro-magnesian minerals from one end to the other. The peridotites certainly intrude the Ordovician limestone, although here the Carboniferous sandstone has been removed by erosion (if it was ever deposited originally), and the intrusive nature of the igneous mass into the Carboniferous strata cannot at the moment be definitely stated.

The associations of these masses show the same relationship as that found in the Adirondacks,[2] although the latter masses belong to a much earlier geological period.

Chrome Point — Fox Island River. — Passing northward to the mouth of Fox Island River, a distance of some 10 miles, and following up the river to its source, one of the large peridotite masses appears. The hand specimen shows a soft rock, varying in colour from dark green to a light yellowish green, and having the smooth, slickensided surface so often found in serpentine masses. An examination of the thin section shows the rock to be composed almost entirely of a serpentine matrix with diopside and diallage crystals, and some black specks of ore (probably chromite) scattered through it.

On the borders of this mass appear deposits

[1] United States Geological Survey Annual Report, No. 8, pt. ii.

[2] *Bull.* 119, New York State Museum, pp. 63 and 67.

of chromite. One of these, on the western edge, has been worked,[1] while another on the south-eastern edge has been prospected but not developed. Samples of ore, taken from the second locality, show that the grade is good enough for economic work provided there is a sufficient tonnage available.

The peridotite appears to be intrusive into sediments, and one striking feature of the locality is the barrenness of the peridotite itself compared with the growth of trees on the closely adjoining metamorphic rocks.

As a matter of some interest, it may also be noted in passing that a lake, situated here on the divide between the stream drainage, has one exit through a normal stream which flows eastward and eventually joins Harry's River, while a second stream apparently plunges into a hill and empties itself through an underground passage into Fox Island River about one mile further south. At least, this is the explanation people give of the phenomenon, but the actual course of the underground stream has never been exposed.

A small deposit of asbestos is found in another outcrop of peridotite at a distance of 15 miles eastward from the one just described, and within four miles of the railway. The country here is very densely wooded, and it is very difficult to see any outcrop of rock, the asbestos prospect only showing up where operations have been carried on. The actual veins cannot be seen in place, as the excavations have fallen in; only the material on the dump can be examined. Judging by this, the veins are about ½ in. to ¾ in. in width and are very numerous, and the fibre itself is the true commercial serpentinous variety, although not so soft as the best quality of fibre produced at Thetford, Quebec.

Bay of Islands. — At Summerside, on the north side of Humber Arm, Bay of Islands, and at Birchy Cove, on the south side, purple slates appear in which quarries have been opened up but are now abandoned. Further up the arm, at the point where the Humber River enters, limestones appear. It would be an interesting study to endeavour to find out if these argillaceous sediments, in which the slate quarries exist, are related in any way to the red and green shales on the southern portion of Shale Point, as might quite well be the case if the beds followed the trend of the synclinal trough. The sediments in the two localities are alike lithologically, and their position with reference to the limestones suggests that their stratigraphical relationships are the same.

In Wild Cove, Humber mouth, there is a mineral spring, which, at low tide, spouts about a foot into the air. An analysis of the water showed it to contain 330 parts per 100,000 of sodium chloride in addition to other salts. This spring may be on the contact between the slates and limestones, though this point was not determined.

The next locality visited is situated on Goose Arm, Bay of Islands. Here the limestone, probably a continuation of the same belt seen in Port au Port, contains very small quantities of pyrite. This material has been mined, but the workings are now abandoned. The limestone itself is very pure and would do excellently for burning for quicklime and for use as a flux in furnaces. The origin of the pyrite could not be definitely determined without a further expenditure of labour than was at the time possible, owing to the fact that the locality is covered with undergrowth, that the excavations have fallen in, and the shaft is full of water.

A journey was made from here to South Arm of Bonne Bay, following the abandoned telegraph line which runs over the limestone just eastward of the northermost peridotite mass. On the edge of this mass in the peridotite itself, near Woody Point, occurs a mineral spring.

The following are analyses of the water of the two springs :—

	Bay of Islands.	Bonne Bay.
Calcium Bicarbonate ...	17·90	
Calcium Chloride.......	5·03	6·72
Magnesium Bicarbonate		7·32
,, Chloride....	45·04	
,, Sulphate ...	51·65	
Sodium Bicarbonate....		7·20
,, Chloride	335·6	16·44
,, Silicate	0·70	3·09
,, Sulphate		2·28

The water from Bay of Islands smells of hydrogen sulphide. It is colourless, is slightly acid to litmus, and has a saltish taste.

The water from Bonne Bay is colourless and alkaline to litmus, methyl orange, and phenolphthalein. It has a brackish taste and little or no smell.

[1] G. W. Maynard, *Trans. Am. Inst. Min. Eng.*, vol. xxvii, p. 283.

MINERAL RESOURCES OF LOWER KATANGA, BELGIAN CONGO

By G. TREFOIS and J. HENRY RICKARD

INTRODUCTION.—Little is known of the mineral and other resources of the Congo. A large number of books deal with that country, but they treat the subject superficially, and interesting and valuable information is often lost in a medley of commonplace topics and is consequently overlooked by the reader. What is wanting is a series of monographs dealing with the different provinces of the colony. The Government problems and the opening up of the territory should be dealt with by colonials or by those knowing the country well, who by their training and experience of Africa are better able to give clear and exact information to the general public than outsiders.

The writers, in the following pages, will attempt to give one of these monographs, consisting of a brief description of some of the principal ore deposits discovered, up to date, in Northern or Lower Katanga. They will not deal with the Union Minière copper mines, and will refer but little to the tin mines of the same company, which are all in Higher or Southern Katanga. The description of the mines owned by that company would require a separate study and could only be obtained through some of the engineers who have been or who are employed by that well-known and potent company.

Before proceeding to describe the deposits, it is perhaps well to state the general conditions leading up to the development of mining and metallurgy in that province.

Katanga is in the heart of the African Continent ; its western boundary nearest the Atlantic is at a distance of 1,100 kilometres, and its eastern boundary is more than 900 kilometres from the Indian Ocean. The magnificent network of waterways of the Congo is one of its greatest assets, and this stops practically at the gates of Katanga, for the upper reaches of the Congo River from Kongolo to Bukama and the Luvua from Ankoro to Kiambi are only navigable to steamers during a few months of the year. The Congo is known as the Lualaba above Kongolo, and the Luvua, which rises in Rhodesia, is a very important tributary.

At the commencement of colonization it took travellers many months to reach Katanga, either by starting from Zanzibar or St. Paul de Loanda, or again from the highest point reached by steamer on the Kassai. In spite of this, the richness of the copper deposits and its presumed richness in other minerals resulted in Katanga, the last province occupied by the Belgians, being the first to benefit by an active, industrial development.

The opening of the railway from Broken Hill to Elisabethville joined the capital of the province to the South African Railways and gave to the mines an outlet through Beira. Later the line from Kigoma to Dar-es-Salem opened communications between Lake Tanganyika and the Indian Ocean. Then the line Albertville-Kabilo and an all-year-round navigation between the latter place and Kongolo, also the line Elisabethville-Bukama with communication by steamer to Kongolo during certain seasons of the year, gave an outlet to the West Coast. Soon the railway to Lobito Bay will be the shortest route to the Atlantic, and the line in construction between Bukama and the Kassai will form a junction between South Katanga and the river system of the Lower Congo.

The improvements of transport during the last 10 years (including the years of the Great War) is very satisfactory. The realization of projects decided on and to be carried out forthwith will give a further impetus. Notwithstanding this the province will always be at least 1,000 kilometres by rail from the sea, which means that the only products of commercial interest are those that can be consumed in the country, or those, having a greater value, able to stand freight charges for export.

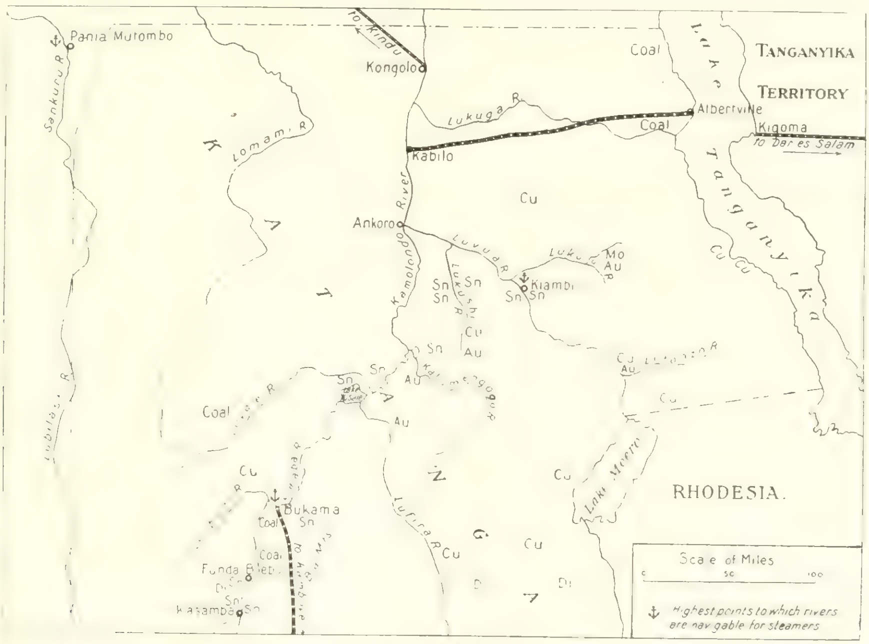
Katanga yields no vegetable products for export excepting rubber, but it can produce food for the native population. The lakes and rivers are teeming with good fish ; on the high plateaux cattle-raising is easy, and the same region is adapted to the cultivation of different grains and potatoes. Maize, sweet potatoes, cassava, ground nuts, beans, bananas, etc., are grown on a fairly large scale near all the native settlements. The future prosperity of the country, however, is based on the mining industry.

Before giving a description of the

discoveries relating to mining and its possibilities a word must be said on the conditions of native labour. As a whole Katanga is sparsely populated ; the continued inter-tribal warfare, and the active slave trade preceding the Belgian occupation, also the much-dreaded sleeping sickness which followed, have decimated the population. Even in normal times it was less dense than in most of the other Congo provinces owing to a poorer soil and the relatively cold climate of the higher plateaux, which, although healthier from our point of view than the lowlands, is not suited to the scantily clad black. The native, on the whole, is not very robust and loves work as little or much as most of his coloured brethren ; at the same time, he is not, as a rule, refractory to a little moral persuasion and a certain degree of education. Thus it is possible to find the necessary labourers for the mines and other works connected therewith, either in Katanga proper or the adjoining provinces. Let us for a moment go outside our sphere in saying that difficulties in recruiting natives, for any sort of work and for which the employer is willing to pay liberally, are due to legal hindrances inspired from a sentimental humane point of view so misguided as to be in direct opposition to the well being of a population they are supposed and have the pretention to protect.

The transport charges prohibit the winning for export of coal, mineral oils, iron, steel, manganese, and zinc, antimony, lead, low-grade copper ores, also building stone, marble, phosphates, bauxites, lime, and cement. The articles that can stand transit and export are rare minerals and precious stones, copper metal, high-grade copper ores, tin, tungsten, mercury, cobalt, uranium, etc.

As regards the consumption of metals on the spot or near by, it is very small to-day and there is not much prospect of a great increase in the near future. A certain quantity of rails is required for building and the upkeep of railways ; also iron sheeting for roofs, iron girders, etc., for bridges, sheds, and houses, iron piping for drainage and water supplies. Both iron and copper are required for household utensils and fittings, also for tools. All these summed up represent such a small quantity that there is no scope for Katanga to compete with the up-to-date and well-equipped factories of Europe and America, notwithstanding the heavy transport costs for importing these goods. On the other hand domestic and local consumption requires fuel for locomotives, steamers,



MAP OF LOWER KATANGA.

mine engines, and smelting works, as well as fluxes such as lime and iron oxides for the treatment of lead and copper ores, and limestone for making lime and cement.

Having briefly mentioned the mineral resources that can be exploited to a commercial advantage, it might be thought fit, before attempting to describe the different ore occurrences now known, to outline what led up to their discovery. The methods employed are neither new nor special to Katanga, and to enumerate them would involve details out of proportion to the present article. We will, therefore, pass on to the description of the discoveries to date.

As said at the beginning of this article, our review will be confined to what is known as the Urua, that is to say, Northern or Lower Katanga, and will not touch the properties of the Union Minière in Southern or High Katanga.

GEOLOGY.—Katanga forms part of the belt of older series of rocks surrounding the Congo basin. The metamorphic rocks, with great granite bosses, occupy a large tract of it. These are sometimes covered with Palæozoic and post-Paleozoic rocks generally lying very flat and occupying among other regions the larger part of the lowlands in the north. Up to now, fossils have been found in the upper strata of the post-paleozoic formations only. It is difficult to class the oldest rocks. Mr. J. Cornet, and more recently, Mr. Studt, have proposed to give them a local definition which might be useful for a detailed geological study, but for our present purpose it is only necessary to divide them as follows :—

(*a*) The Archæan rocks, highly metamorphic, composed of gneisses, mica-shists, quartzites, etc.

(*b*) The less metamorphosed rocks, such as crystalline phyllites and quartzites.

(*c*) The Palæozoic sedimentary rocks with conglomerates, sandstones, schists, and limestones.

(*d*) The post-Paleozoic rocks which Mr. J. Cornet divides from bottom to top into three systems, namely : Kundelungu, Lualaba, and Lubilache.

Tin and monazite are found in the metamorphic rocks in or in proximity to granite. Gold is found in the first two formations, (*a*) and (*b*), but chiefly in the second. Copper occurs principally in the third. Coal only exists in the fourth and more especially in the middle Lualaba series. Diamondiferous pipes (blue-ground) have been discovered in the Kundelungu, and the amygdaloidal diabases in the second series may also be diamond-bearing.

GOLD.—Placer gold has been found in river wash in quite a number of places, and, with few exceptions, reefs or lodes from whence it was shed have not been traced.

In the higher valley of the Lufira quartzite lodes in sandstone and schist contain auriferous iron pyrites, and gold is visible to the naked eye on the outcrop. The development operations are not yet completed, but they give hopes of opening up a fairly important mine.

In the Lufonzo valley, a right tributary of the Luvua, quartz lodes containing iron pyrites, with a little gold and silver, occur in crystalline schist and quartzite formation, crossed by diorite dykes and near a granite boss. The lodes are small, from 0·40 to 1 metre wide only ; iron pyrites is present in nodules but more generally in specks throughout the gangue. The gold content is very low, averaging 1 to 3 grams with 15 to 20 grams of silver to the ton of pyrites. The lodes are considered to be of no value.

The only mine that has been worked to any extent is Ruwe, which yielded gold and platinum. Mr. H. Buttgenbach has given a full description of it in the " Annales du Musée de Tervueren " in 1908.

In other cases, it is almost certain that the gold found in the alluvials comes from similar quartz and pyritic lodes occurring in metamorphic rocks. These lodes in the Urua are usually found in schists, sandstones, and quartzites of the Kabele system (Mr. J. Cornet) of class (*b*).

Alluvials carrying gold over small and large areas have been discovered in the high valley of the Muniengashi, a left tributary of the Luapula, in the higher Lufira, the higher Lualaba and several of its tributaries and smaller streams, in the Kamelondo-Lualaba flats, also in the higher valley of the Lukishi confluent of the Luvua, in the Kalumengogo, a tributary of the Kamelondo-Lualaba and its several streams, again at Kafinga, Mukuluji, Pemba, etc., etc.

The gravels which seemed to justify being prospected on account of their extent or richness have been sampled. The highest values found, about 1 gram per ton, are few and far between ; thus the alluvials in the foregoing localities fall below the average at which they can be treated economically by either dredging or sluicing.

Up to now, Katanga has no operating gold mine or placer, for one can hardly call Ruwe a mine. The work was suspended many years since, and nothing has been done to renew operations in spite of the high price of platinum and the premium on gold. Ruwe is the only place in the province where platinum has been found.

No silver has been discovered excepting small quantities in copper, iron pyrites, and lead ores.

TIN AND COPPER.—Before dealing with these minerals in detail we would state that the discoveries of both tin and copper ores are very encouraging Prospecting, which is being continued, has opened up valuable areas of alluvials carrying good cassiterite contents. The copper deposits promise a very large tonnage of rich sulphide ores. These may prove to be of even greater value and much easier to treat than the carbonates, oxides, and silicates known previously.

TIN.—Tin is found over large tracts of country and in the beds of several waterways. It is always adjacent to the granite formation. In some places it has been possible to discover the lodes and deposits from whence the alluvial tin was shed. It would seem, however, that the cassiterite was sometimes a constituent of the granite itself, especially muscovite granite. Often it comes from dykes of pegmatite, greisen, or quartz in granite formation or on the contacts of granite with mica-schists and gneisses, but above all from the crystalline rocks of the Busanga system (Mr. Studt).

In these formations the cassiterite content is sometimes so small that the means employed by the prospector fails to detect even traces by panning several kilos of pulverized rock. It was only by a sluicing operation on a gigantic scale by nature itself that tin is found in a certain degree of concentration in the alluvials shed from these series of rocks.

In places, especially near the bends of the older rocks, the masses of pegmatite, greisen, and quartz veins contain high tin values.

Mr. H. Buttgenbach gave in the "Annales du Musée de Tervueren" a general description of the tin-bearing lodes, etc., in the Bia Mountains.

In their continuation, towards the south, at a place called Kasamba, deposits of rich cassiterite are found associated with mica in quartz lodes. No doubt these have shed the valuable alluvials and gravel beds in the vicinity worked by the Union Minière at Busanga.

To the north of the lower Musonoie, left feeder of the Lualaba, similar lodes have been discovered. They appear to be of too low grade to be of economic importance, but they are certainly the source of the very rich tin gravels found near by.

To the north of Lake Kisale there are a series of quartz lodes in mica-shists and crystalline rocks, near granite, containing copper pyrites, mispickel, lead, and a little tin. They are irregular and of low grade.

Near Kiambi on both banks of the Luvua a large number of pegmatite and greisen lenses carrying tin oxide have been found in conjunction with phyllites and quartzites; they seem to occur principally where the direction of the latter rocks changes abruptly. These lenses, as a rule, follow the strike and dip of the surrounding rocks. Their size varies considerably. Some have been found with an area of several acres; others are smaller; on an average they have a surface area of roughly 2,000 square metres. A few have been proved to be mineralized to a depth of 30 metres, which is the maximum depth of the present mine workings, but it is certain that the cassiterite persists much deeper. The tin content varies. The highest values are 20% tin oxide, but the average of the greisen is about 2% SnO_2, and the pegmatite assays 0·25 to 0·50 SnO_2. As a whole this formation cannot make a very important exploitation, but the richer part can be worked by open-cut mining in conjunction with the hydraulicking and sluicing of the tin-bearing gravels found at surface in the immediate vicinity.

In the Kibale Hills situated at the source of the Kanjwa, which falls into the Lukushi, there are several parallel reefs of pegmatite and greisen, in granite formations, containing small quantities of tin. The mineralization is irregular and does not appear to be of any economic value.

Towards the source of the sub-tributaries of the lower Kalumengongo there are several lodes of pegmatite, greisen, and micaceous quartz containing tin and a small quantity of molybdenite; these, too, are not rich enough to be worked.

In conclusion, up to the present, no occurrence of tin ore in situ has been discovered to be worthy of the name of a prospective mine, but at the same time many localities warrant further trials either by shaft-sinking or diamond-drilling.

The alluvial and gravel deposits coming from the tin lodes, etc., give quite another outlook. Already very rich wash in the form of gravels in stream beds and terrace deposits have been discovered in many localities, and they are being worked in at least five districts.

Some gravels are very rich, especially the eluvium from the tin-bearing bodies above described ; 5 to 10 kilos of cassiterite to the ton of detrital material is a frequent occurrence, and finds of 120 kilos of cassiterite to the ton have been reported. With the low working costs such deposits can be treated at a very high profit. The average yield of tin oxide per yard of material is much higher than the average of the Nigerian tinfields, where working conditions are very similar excepting that the natives of Nigeria have been trained to tin sluicing and calabashing (panning) for a number of years.

The rich gravels in stream beds are limited to the head waters of torrents crossing stanniferous deposits. These streams in places form natural ground sluices where tin is concentrated. In the larger rivers the tin brought down by the feeding streams is mixed with a large proportion of sterile matter. The wide section of these waterways and their depth is not favourable to any concentration of cassiterite.

The most important tin deposits of Katanga are those known as eluvium coming from the outcrops of pegmatite and greisen. The detritus has undergone an enrichment by the loss of its soluble felspathic contents and also by rolling down and fanning by wind. Where there is a large area of this tin-bearing eluvium, or a number of smaller areas in close proximity, the surface ground may contain enough ore to be taken into consideration as a placer.

Large tracts of country are covered by eluvium deposits which have been proved to yield 200 to 300 grams SnO_2 per ton ; 600 to 800 grams are common and the richest yield 1 to 10 kilos SnO_2 per ton. It is only the latter that will be dealt with by us in the present article as being on a paying basis under actual conditions.

Scene on the Luvua River.

Most of the richer deposits have been sampled, and we will give below the tonnage of the proved ground.

South of Fundabiabo (where trials are not yet finished) 200,000 tons of eluvium yielding 3 kilos of cassiterite per ton = 600 tons.

On the opposite bank of the Lualaba two deposits will yield at least 5,000 tons of cassiterite.

Lower down the Lualaba, on the right bank, a deposit lately found is being

Screening Tin Gravel before Hand-Jigging.

Method of Hand-Jigging Tin Gravel.

explored; it promises to give a very large tonnage.

Around Lake Kisale is a group of less importance, the whole of which contain 2,000 tons of cassiterite in gravel carrying 2 kilos to the ton.

Further east between the Kamolondo-Lualaba and the Luvua, there exists another group of deposits of which a few only have been thoroughly proved. One of these contains 15,000 tons of cassiterite in gravel going 2 kilos and another 10,000 of cassiterite in gravel containing 1 kilo per ton. The prospecting here adds daily to the reserves of profitable ground.

To-day Katanga has some 60,000 tons of tin oxide which can be won on a paying basis, and in fact at a very handsome profit if the workings are skilfully conducted.

For reasons too long to go into here, the prospecting, sampling, and surveying of the alluvial and eluvium masses present certain difficulties, also long and patient work.

Up to the present vast regions which have great possibilities for as good or better tin discoveries than those we have mentioned have only been roughly gone over or "scratched." It is certain that the deposits found up to date, although important, represent but a small portion of the workable tin-bearing ground in the province.

As stated before, the winning of tin from these gravels should be very remunerative. Working under similar conditions to those of Katanga, in other countries alluvials are washed at about 0·50 francs per ton. In Katanga small running tests with trial plants and untrained labour worked out under 1 franc per ton. Recently another report gives 1·50 francs per ton. In taking into consideration the present high price of labour and materials we will consider 2 francs per ton as a maximum figure. Then taking tin oxide to be worth 2,500 francs per ton on the mine, the limit of paying gravel would be one containing 800 grams cassiterite to the ton. The average gravel of Katanga, containing about 2 kilos SnO_2, to the ton, would give a profit of 1,500 francs or 90,000,000 francs on the tonnage already known.

The war has hindered the opening up of the mines and placers which are now being worked by three companies. The production of tin oxide concentrate during 1921 was not more than 1,000 tons, but at present several large plants are in the course of construction, so that the output should increase rapidly from now onwards.

The concentrates carrying 68 to 74% SnO_2 are shipped to Europe, but it has been proposed to erect smelting works in the country and to produce and export the refined metal, thus saving 30% in transport, also the cost of bagging and losses in transit. These items are a considerable expense when one takes into account that the concentrates are sent to Antwerp via the Congo River, and have to be handled altogether no less than 16 times.

(To be continued.)

LETTERS TO THE EDITOR

Iron-Ore Resources

The Editor:

SIR—Your Editorial on iron-ore resources in the October issue was opportune, but I fear that many readers will remain unsatisfied with the situation, as, indeed, you must be.

At the Stockholm meeting of the International Geological Congress in 1910 an attempt was made to determine the world's iron-ore reserves, and subsequently estimates have appeared in publications of different countries, with the result that we have now a plethora of confusing figures.

It is true that in the preparation of these estimates the calculations for different countries are supposed to have been drawn up on similar lines, but in actual practice those who have been good enough to undertake the work, generally individual geological observers, have made their own rules and established their own view-point in describing their particular type of deposit, with the result that the estimates have little value for comparative purposes, and even may be misleading in their international application.

The generally accepted method of dividing ore reserves into actual, probable, and possible was devised to control those who had more imagination than discernment in dealing with individual properties containing ore likely to be worked within a relatively short period. The application of the same method in estimating ore reserves by countries has brought about the very abuse it was intended to avoid.

It is difficult to define iron-ore reserves by existing standards, for the valueless material of to-day may be the profitable mineral of the future, but it cannot be right

to place in the same column as actual reserves iron ore which is being profitably worked on a large scale, with that not likely in our time to be utilized in any appreciable degree. Further, it is difficult to imagine what useful purpose can be served by extremely hypothetical figures regarding probable and possible mineral, which if used at all would only be by future generations.

I do not propose, however, to criticize published estimates in detail, for they are the fault of the system, or the absence of one, but I rather wish to register a plea for more rational treatment of this important subject.

It has, I believe, been suggested that the Stockholm figures should be revised, but I trust that this work will not be undertaken before it has been discussed with mining engineers and those representing the economic view-point, in addition to geologists, in order that a common basis of calculation should be agreed. A committee similarly constituted should function in each country, and submit their conclusions to an international revising board before publication.

It may be contended that objection would be raised to the last proposal, but this should not arise, for the estimates can only have general value if properly co-ordinated.

I think you are in error in stating that increasing amounts of iron ore are being shipped from Brazil to the United States, for under present transport conditions that could hardly be profitable. Your remarks, if applied to manganese ore, are probably correct, for the United States Steel Corporation took over some time ago the Morro da Mina property, which is the most important manganese ore deposit in Brazil.

H. K. SCOTT.

London, *October* 27.

The Gold Basis of Currency

The Editor :

SIR—The Editorial in your June issue reviews briefly some of the criticisms to the proposals made in my paper to the Institution of Mining and Metallurgy *re* gold and currency and proceeds to some general comments. The former I shall duly deal with through the Institution. I wish, however, to answer the latter, which I submit either indicate a misunderstanding of my proposal or constitute unfair criticism ; I assume the former.

You say things have largely righted themselves in Britain since I first contemplated my paper. Let us define our objectives. What my proposals aim at are :—(1) The restoration of a common medium of exchange, from the lack of which the nations are suffering acutely, especially Britain, whose prosperity, even her continuation as a first-class power, depends on her international trade ; (2) The effecting of such restoration without the great evils of deflation or the lesser ones of inflation, that is, the stabilization of price-level at its present average ; (3) The restoration of gold to its pre-war function as exchange medium means restoration of, or part of, its pre-war market and demand, with proportionate increase to its value. Your, and others', desires appear to agree with the above.

In what respects has the position improved ? We have not restored a common exchange medium and we still suffer from lack of one. We have lately maintained prices approximately at one level and we have decreased the value of gold. Through the cheapening of gold we have brought its price within 10% of pre-war price, though the general price-level is 60% to 70% over pre-war. We have not restored stability. While inconvertible paper money is the legal tender, there are no economic factors automatically regulating price-levels as is the case when gold is the common exchange medium.

The late and present movement is toward the cheapening of gold. If it continues, it will, even though the average price-level remains as at present, in course of time bring gold to pre-war parity. But it is not certain that it will continue that far. The production of gold of late has only been on the dimensions it has because the industry was already established in a time of higher gold value. The production will decrease even if the present gold value remains. The decrease will be accelerated as cheapening proceeds. If the decrease reaches a certain point the cheapening process will end, unless new factors arise, such as countries, now using gold, abandoning it for paper.

But let us suppose that the process succeeds in bringing gold to pre-war price while maintaining present the general price-level. Have we then got a common exchange medium ? The idea in many intelligent minds seems to be that we can then establish

gold as an effective common measure of value (not medium of exchange) by remaining as now, on a wholly paper basis for internal currency circulation and using gold for foreign balances, the paper being convertible with gold at par for the latter purpose. I submit that the course is experimental and that it may not function effectively. It infers a very close control of paper issue. Otherwise fluctuations, in real value between the paper and gold, of such magnitude as to impede trade are bound to occur. That small fluctuations will occur in spite of close control is to be expected. Whether these could be kept so small that they would not impede trade has yet to be proved.

If this can be done, and it is the only way in which it can be said we are now heading for a common measure of value, and becomes established as the permanent currency system, gold will be given permanently a value of some 40% below pre-war. It is well also to ask :—If this process can be carried to the point described, cannot it be carried further ? Why must it stop at that point ? What is there to prevent an inflation of price-level should the Government of the day consider that such suited their policy ? With the gold basis as it was pre-war, there were natural checks to that process. Inflation under those circumstances would mean further decrease in gold value. The difference between value and price must be borne in mind.

The Editorial's last sentence—that gold should get back to par, wages and costs fall, and then gold mining will recover—seems to infer expectancy of a general deflation in price-level. My paper showed the reasons against both the desirability and the practicability of this. A big deflation would be ruinous to all interests. I am glad to say that this fact is now recognized by all students of the situation.

Your remark *re* the condemnation by the Australian masses of the Labour Party's scheme for creating wealth out of nothing has not the remotest connexion with my proposals. I presume it means that the said Party has advocated currency inflation. Nothing could be more unlike my proposals. It is what the Governments did during the war, the continued evil effects of which my proposals are designed to terminate, by stabilizing price-level and restoring a common exchange medium. My aim is simply to restore pre-war conditions, relative real values being as they were then. The difference would be only in nominal values, in figures. I propose to let this difference remain because it is already well established and it is injurious, probably impracticable to now remove it.

The comment that France and Italy have expressed determination to struggle back to par is suitably worded. It will indeed be a "struggle." It would be informative to hear whether they propose first to repay their national loans ; or do they propose to multiply these (in real values) by two or three as the case may be ? Do they really intend to deflate prices to a fraction of the present level ? If so, then truly the losses of peace promise to be greater than those of war.

H. R. Sleeman.

Whim Creek, W.A.
August 17.

BOOK REVIEWS

American Sulphuric Acid Practice. By Philip de Wolf and E. L. Larison. Cloth, octavo, 270 pages, illustrated. Price 17s. 6d. net. New York and London : McGraw-Hill Book Company.

The author's declared purpose in preparing this volume has been to provide some fundamental information for the man with little preliminary knowledge of the subject, and it is a pleasure to testify to the clarity and conciseness with which they have done their work. While not covering the ground with the thoroughness of Lunge or the detail of the Technical Records issued by our own Department of Scientific and Industrial Research, this handbook may be relied upon to give an accurate and well-balanced summary from the technical view-point.

In the introductory chapter, the development of the industry, more particularly in the United States, is traced briefly from the earliest times. The only statistical matter included shows the growth in the world's production of from 1,850,000 tons in 1880 to 8,000,000 tons in 1909. Chapters on "the elementary chemistry of sulphuric acid" and "its characteristics and uses" are adequate in the circumstances. It appears that in normal times 80% of the acid produced is consumed in the manufacture of fertilizers (superphosphate and ammonium sulphate).

In discussing the advantages of sulphur over pyrites as a raw material, the authors claim that this has been demonstrated by the willingness of the acid producer to pay

a higher price per unit for elemental sulphur than for combined sulphur in the form of pyrites, and they state that, in making a large contract, one of the largest and best organized chemical companies in the United States chose sulphur over pyrites when the differential in offered prices was 8c. per unit of sulphur. Sulphur is constant in composition, and its freedom from arsenic and other impurities allows the production of purer acid. It is also pleaded that in buying imported pyrites the American consumer is putting himself at the mercy of one large set of interests. It is suggested that an actual offer for large contracts of pyrites at about 10c. per unit of sulphur, ex vessel Atlantic seaboard, while pyrites was selling in England (much nearer the base of supplies) at 20 to 22c. per unit, was for the purpose of extinguishing a competitor with no permanent advantage to the consumer. The United States had in recent years consumed upward of 500,000 tons of sulphur in the form of pyrites, mostly from Spain. During the war years, owing to transport conditions, the importation fell off seriously, thus causing many producers to discard the pyrites roasters and to instal burners for the home-produced sulphur.

The chapter on the production of SO_2 gives a description of the various types of burners, roasting furnaces, and sintering machines in use. The metallurgist will be interested in the utilization of by-product gas from ore-reduction works, and particularly in the short description of plants in the Ducktown district where the conditions are such as to allow blast-furnace gases being used as a source of SO_2 for acid making.

The authors also refer to the recently introduced "silica gel," whose commercial production has been made possible by the war-time researches of Professor W. A. Patrick on gas-mask absorbers. The property of this material to absorb in large quantities any condensible gas, and to release it upon a slight rise of temperature, may make available for acid-making and other purposes the weak SO_2 gases derived from sintering machines.

The authors express the opinion that while the contact process has many advantages over the chamber process, it is very doubtful if it will ever completely replace the latter. For the production of higher-strength acids it is supreme, but for the weaker acids used in many industries, the chamber process is cheaper.

Further editions of this book will be surely called for, and an opportunity will then occur for correcting some misprints (one does not like to see Messel's name written with a W) and for giving information concerning the Anaconda packed-cell plant, with which, it is understood, the name of one of the authors is associated and which, by the elimination of lead chambers, promises an advantage over an ordinary chamber plant in reduced cost of construction.

William G. Wagner.

An Introduction to Sedimentary Petrography. By Henry B. Milner, M.A., D.I.C., F.G.S., A.M.I.P.T. Cloth, octavo, 130 pages, illustrated. Price 8s. 6d. net. London: Thomas Murby & Co.

This excellent manual claims to be only an introduction to the subject, but it is something more than this, for the author not only presents fundamentals in a lucid and concise form, but he extends this introduction by chapters containing much that is original and stimulating — the outcome of considerable experience and research.

An appreciation of the work of those geologists who have already made substantial contributions to progress in this subject is followed by sections describing (1) methods of sampling and treating sediments to be investigated by the microscope, and (2) the main physical and optical properties of significant minerals, from gold and diamond to quartz and calcite. The concluding chapters examine the extent to which mineral assemblages (qualitative and quantitative) can be, and have been, applied to the correlation of strata and to the reconstruction of palæogeography. There is a bibliography comprising 82 references, and the book is well illustrated by admirable plates representing typical mineral grains.

The author stresses the need for more work of an interpretative character; qualitative data in abundance are on record, much of which, being uncorrelated and unexplained, stands relegated as it were to pigeon-holes. The mineral composition of a particular gravel or sand may be of the utmost economic importance to the prospector, who may not, however, concern himself with the geological significance of the data before him. The mineral composition of some particular stratigraphical horizon, sampled at one locality, may offer no thrills, yet may be a link in a hidden chain of significant facts of

first-rate importance in its bearing on stratigraphical problems. In recent years, however, the possibilities of sedimentary petrography have been tested with considerable success by oil-field geologists, to whose field-problems the principles discussed in the later chapters of this book seem specially relevant.

The author is rightly content to confine the scope of the book strictly to sedimentary petrography. He assumes the beginner to have a working knowledge of crystallography and optical physics, to be familiar with the use of the quartz wedge, etc., and to be diligent enough to consult the standard works on these allied subjects when perplexities arise, as they inevitably will. Microchemistry as an aid to the diagnosis of mineral grains deserves a little more emphasis, and a reference to Behrens' "Manual of Microchemical Analysis" would have been appropriate.

As a textbook, for the more experienced student no less than for the beginner, it is admirable.

A. Brammall.

Essentials for the Microscopical Determination of Rock - forming Minerals and Rocks. By Albert Johannsen, Professor of Petrology in the University of Chicago. Price 10s. net. Chicago : The University of Chicago Press.

The determination of rock - forming minerals under the microscope must inevitably involve some process of comparison of specific properties with standard optical criteria, thus leading to a gradual elimination of negative factors until the species is recognized. Of the optical properties possessed by non-opaque minerals, probably none are so generally useful in petrographic work as refractive index and birefringence, and Dr. Johannsen uses these two properties to advantage in the present book.

In a series of clear and concise tables the anisotropic species (which form the majority of rock-forming minerals) are arranged with reference to their birefringence as being greater or less than quartz, and to their refractive indices as being greater or less than Canada balsam. Maintaining this principle as a working basis, further differentiation of species is made by grouping together those which are coloured and, distinctively, those which are colourless ; if coloured, pleochroic and non-pleochroic minerals are separated, while the uniaxial or biaxial character of the minerals forms a further basis of subdivision. With this scheme some 150 anisotropic minerals are classified in six tables, each mineral receiving brief discussion in the accompanying text.

Isotropic minerals, of which 23 species (including glass) are listed, receive brief treatment ; they are grouped according to colour and to their refractive indices being greater or less than Canada balsam. One page of text suffices for the opaque minerals, distinguished, as customary, by their colour by reflected light. In addition to the foregoing matter, the book contains condensed hints on the determination of felspars, pyroxenes, and amphiboles, on the modes of occurrence of various minerals, and a summary of petrographic methods. Lastly, eight and a half pages and four tables serve to present to the reader the theoretical and practical principles of the quantitative classification of igneous rocks. So much for the general plan of the book.

The bringing together of the essentials for the microscopical determination of the rock-forming minerals in a manner which makes reference to those essentials both easy and rapid, is a commendable achievement, even though it represents nothing strikingly new in substance. Originality in this case lies rather in the method of handling the data, and the author has undoubtedly realized far more than a mere compilation of facts. There are, however, certain obvious difficulties in the way of any attempt to tabulate mineral species comprehensively, as is the case with igneous rocks. Repetition and overlap are to a certain extent unavoidable. Thus calcite, dolomite, and magnesite appear in three tables according as they are colourless, coloured and non-pleochroic, or coloured and pleochroic ; in the last instance the reason of their inclusion with other pleochroic minerals is difficult to understand. Similarly brookite, olivine, apatite, and siderite appear in the pleochroic group as well as in other tables ; these species are rarely, if ever, pleochroic in thin section.

In the section on opaque minerals one cannot be quite in agreement with the author as to the colours exhibited by certain species by incident light ; for example, magnetite, graphite, and ilmenite are all classed as being black by incident light. Magnetite has more frequently a steel-grey, ilmenite a dull reddish-grey, and graphite a dead-black

colour under these conditions, especially in certain ultrabasic and metamorphic rocks, and also in sediments. In the section on isotropic minerals and with reference particularly to pyrope and fluor, some note should be added on the anisotropic effects frequently observed in these species as a result of strain.

That part of the book which concerns itself with the essentials for the determination of rocks consists in the brief summary of the quantitative classification already alluded to; the lack of universal adoption of this classification tends to restrict the usefulness of this section, while the entire omission of a chapter on rock-structures as interpreted under the microscope is unfortunate. Apart from this the manual should prove a most useful laboratory asset to the student of petrology, particularly when used in conjunction with the author's well-known "Manual of Petrographic Methods." It should be to him what group-tables are to the student of qualitative chemistry, an invaluable guide "to be read, marked, learned . . . ," etc.

H. B. MILNER.

Marine Works; A practical treatise for maritime engineers, landowners, and public authorities. By ERNEST LATHAM, M.Inst.C.E. Cloth, octavo, 174 pages, illustrated. Price 16s. net. London: Crosby Lockwood and Son.

A busy engineer, experienced in one branch of engineering, is frequently called upon to investigate another branch of his profession. He finds he has little time to study a theoretical textbook, but is anxious to make himself familiar with the general technicalities of the problem which confronts him. He may be a mining or metallurgical engineer, and wishes to establish a wharf or pier for the transference of material to or from his works on a navigable waterway. Perhaps he is confronted with the encroachment of the sea or the scour of a river, and is obliged to erect suitable protective structures. He may feel that if the subject were placed before him in a simple practical way he could possibly, for small works, be able to carry out the construction of the necessary engineering works without calling in a specialist. This book meets just such cases.

The book opens with a chapter on waves, their formation, action, and effect. In this section particular attention is drawn to the difference between mere up and down oscillatory waves and travelling waves having some weight behind them. Chapter II deals with the damage to which the several types of engineering structures, that is, piers, bridges, dock-walls, etc., are liable. The author gives instances in which it was found preferable to use timber instead of reinforced concrete for the construction of certain types of piers. In other examples of work such as protective embankments or groynes, he shows the advantage of using reinforced concrete. In Chapter III he discusses the maintenance of tidal berths, and Chapter IV is devoted to the subject of pile-driving. Chapter V is devoted to the consideration of the conservancy of marsh lands adjoining waterways, and Chapter VI to coast defence. Chapter VII deals with the maintenance of navigable rivers which serve industrial areas. This involves efficient care of the navigation channel or fairway; the prevention of flooding the adjacent lands; the discharge of the land drainage; and the control of constructional works, such as jetties and quays, on the river sides. Chapter VIII is devoted to the details of scour and scouring by rivers and waves. The causes are briefly touched upon, particularly the scour effects in tidal rivers, and current velocities are quoted. The velocities which will produce scour in clay banks, silt bars, sands, and gravel shoals are of great interest to the geologist as well as to the civil engineer. The relative advantages of deep-water quays and enclosed docks are elaborated in the last chapter. With the continued expansion of the scale of mining operations, all the above-mentioned problems may come at one time or another before the engineer, and this book will be of great service when the occasion arises.

CYRIL S. FOX.

The Mines Handbook, Vol. XV. By WALTER HARVEY WEED. Cloth, octavo, 2,250 pages. Price £3 10s. Tuckahoe, N.Y.: The Mines Handbook Co.; London: The Technical Bookshop of The MINING MAGAZINE.

This important reference book, giving particulars of mining companies throughout the world, was founded in 1900 by the late Horace J. Stevens as the "Copper Handbook." On Mr. Stevens' death in 1912, the property was acquired by Mr. Walter Harvey Weed, who expanded the scope of the work by including other

metals besides copper, and altered the title accordingly. When the book was founded, the intention was to publish it annually, but owing to the immense amount of labour involved in collecting the information, this has not always been possible. During later years no attempt has been made to secure an annual issue, and successive volumes now appear at intervals of approximately two years.

As regards the countries covered, it is natural that the United States should take first place, with Canada and Mexico receiving about equal attention. Within this compass the information given is excellent and as complete as possible. When, however, we turn to the sections devoted to other countries of the world, it is found that only a tithe of the mines and operating companies are mentioned. This scant treatment may be appreciated by the fact that South America and the Eastern Hemisphere occupy only 250 pages out of the total 2,250 pages. For instance, under the heading of Sweden, all that is mentioned is the Lake Copper Co. Apparently only those companies that are financed in the United States and England have been canvassed. It might be expected that a book published in the United States would deal only with the better known mines in other countries, but here this rule has not been followed, for among the English mines mentioned there are some " precious duds." However, this is the only fault that can be found with the work, and in any case those who consult it will rapidly see that the information about North American mining is that which counts.

The Handbook is in some respects similar to Skinner's Mining Manual, and fills the same function for North America that Skinner does for the London mining market. The Handbook goes farther, however, and touches on the mining, metallurgical, and geological problems of the various companies, so that it is of considerable interest and help to the technical man as well as the financier or speculator. This feature is due to the fact that the editors have been engineers ; Mr. Weed, in fact, is one of America's leading mining geologists. Another point of difference between the Handbook and Skinner is that, while the latter relies solely on information officially obtainable either at Somerset House or at the offices of the companies (taking care, of course, that no unsuitable matter shall be inserted), the Handbook does not confine itself to bare facts, but adds editorial comment where suitable. It presents information from other sources when the companies are not to be drawn, and sometimes this information is the reverse of flattering to the company in question, the criticism being occasionally scathing. On the other hand the comment is often kindly, both to well established companies and to beginners. The Handbook also contains chapters on the mineralogy of ore minerals, and the statistics of production and distribution, and there is a good glossary.

With the reservation as to scope beforementioned, we can say that the Mines Handbook is an invaluable reference book for those interested in mining operations.

NEWS LETTERS

BRISBANE

September 30.

An Old Goldfield Revived.—During the past year or two there has been quite a revival in an old goldfield in North Queensland—the Normanby—that had for a very long while previously been practically abandoned. While some old mines on this field have been taken in hand, on ground, also, outside of the area previously worked several new reefs have been found ; on a number of holdings prospecting, development, and productive work is being actively carried out, and the place that was once deserted and silent has become a busy centre. The field is situated 50 miles southerly from the northern port of Bowen, and has hitherto been greatly handicapped by difficulty of transport, the road between the goldfield and Bowen, crossing the coastal range, being particularly rough. A much better means of outlet, however, has now been found, giving communication with the head of the newly opened railway from Bowen to the Bowen River coalfield, which lies north-easterly of Normanby, distant between 35 and 40 miles, with no range to cross. Several mines that have been started on the Normanby are giving good prospects, two or three of them especially so. The one that is so far turning out best is the Frederick, owned by the Billy Hughes Gold Mining Company. In this mine old workings that had been abandoned as far back as 1893 were opened up by this company, which was formed at the end of 1921, and prospecting was started from the bottom of

the shaft, down only 50 ft., by means of a drive in a direction opposite to that in which the original owners had looked for the gold, as well as by the further sinking of the shaft. The new drive has been taken 45 ft. on the reef, which at last report was as much as 4 ft. wide, and giving values of 2 oz. 4 dwt. per ton; while adjoining the reef there is also 1 ft. of rubbly ore giving 1 oz. to the ton. At the same time the shaft has been going down on ore 2 ft. 6 in. wide, giving $1\frac{1}{2}$ oz. per ton. The Billy Hughes, another mine owned by the same company, has also been developing well, and from this property and two others there are 50 tons of good ore at grass awaiting treatment. At present there are no crushing facilities on the field, but the Billy Hughes company is providing a mill, with twenty head of stamps, that will be ready for use before Christmas. The mill, besides dealing with ore from the various mines of the company, is to crush for the public, and in anticipation of its erection quite a number of "shows" have been opened up, and have ore on the surface ready to be operated on.

THE KANGAROO HILLS TINFIELD.—Good reports continue to come from the Kangaroo Hills tinfield, which lies about 80 miles northerly of Townsville. Both the Sardine (now the best tin mine in Australia) and the Shrimp continue to improve with depth, and several other mines in the same locality are showing excellent prospects. In the Sardine a new make of ore has lately been met with, about 18 in. in width, and having a value of 15 to 20% of black tin over a present width of 6 ft., while other parts of the mine are showing even better results. The last two crushings totalled 122 tons for a return of $24\frac{1}{2}$ tons of black tin, or 20%. A twelfth dividend has recently been declared, making a total distribution from the profits of the mine of £28,000 during its short career of less than two years.

MOUNT QUAMBY GOLD MINE.—This, the only gold mine in the Cloncurry copper area, has had its first crushing, 125 tons yielding 51 oz. of smelted gold. This mine, discovered a couple of years ago, is a low-grade proposition, consisting of a big deposit of conglomerate worked by means of open-cut and a tunnel. The return now reported gives a value of a little over 8 dwt. to the ton. The ore being easily and cheaply worked, the owners had estimated that an average return of 5 dwt. to the ton would give a good profit.

BOWEN COALFIELD RAILWAY.—Last week a new railway 54 miles in length, connecting the Bowen River coalfield with the port of Bowen, and consequently with the northern railway system, was opened for traffic. This makes available large additional supplies of first-class coal, well suited for both steaming purposes and for coke-making, and will enable the northern division of the State to obtain its supplies of fuel at a much lower cost than when it had to be drawn from the southern collieries. The new coalfield, which has been opened up both by the Government and a private company, will be able to turn out a vastly larger output than can be consumed locally, and an overseas trade is to be sought for its product.

TORONTO

October 9.

METALLIC PRODUCTION OF ONTARIO.—Returns received by the Ontario Department of Mines for the first six months of the year show a total metalliferous production valued at $14,448,312, as against $11,363,652 for the corresponding months of 1921. The production of gold shows a marked increase, the output being valued at $9,845,247, as compared with $5,761,504 for the first half of last year, and the output of silver also shows a gain, amounting to 4,774,666 oz. valued at $3,273,247, as against 4,277,762 oz. of the value of $2,552,125.

PORCUPINE.—The Hollinger Consolidated, which maintains its position as considerably the heaviest producer, is now producing at the rate of about $1,000,000 per month. The plans for doubling the capacity of the present mill and constructing a power plant on the Abitibi River now under consideration will not involve any reduction in dividends, as the present surplus of $6,000,000 will more than suffice to meet the outlay involved.

The production of the Dome Mines during September amounted to $423,059, its previous highest record for any single month being $377,000. The mill treated 31,304 tons of ore with an extraction averaging $13·51 per ton. Production for the first half of the company's financial year ended September 30 amounted to $2,160,000. Operations are being carried on at the 12th level about 1,650 ft. down, where high-grade ore is being taken out. The Dome has 400,000 tons of broken ore in the stopes, and has not yet started to draw upon the ore of the Dome Extension property.

The McIntyre is increasing its milling

capacity from 750 to 1,000 tons per day. Its main shaft is now down 2,100 ft. and active development is being carried on at a depth of 1,875 ft. The carbonaceous ores which occur between the 1,000 ft. and 1,500 ft. levels, and were for some time the cause of considerable difficulty, do not extend to the lower workings. A new steel head-frame is to be erected over the main shaft, which will enable work to be carried on to a depth of 5,000 ft. The McIntyre has secured a six months' option on the Schumacher Veteran claim adjoining the Dome, the ultimate purchase price being $400,000.

The Davidson Consolidated will sink an incline 3-compartment shaft below the 1,000 ft. level, and has secured hydro-electric power. The shaft of the Goldale has reached the 500 ft. level, and lateral work is under way to reach ore-bodies indicated by diamond drilling. A small mill has been placed in operation at the Clifton-Porcupine. The West Dome Lake, consisting of the merged properties of the Dome Lake and West Dome, has been reopened and the shaft will be put down to 1,000 ft. Arrangements have been completed for the installation of a 200 ton mill on the Night Hawk Peninsula property, which carries ore stated to assay $13 to the ton.

KIRKLAND LAKE.—A strike of rich ore at the 1,000 ft. level of the Kirkland Lake mine is regarded as highly important in relation to the future of the camp, as this depth is 300 ft. lower than that of any other mine in this area. Extensive improvements will be made in the plant of the Lake Shore. The shaft will be enlarged from the surface down to the 400 ft. level. The mining plant has been increased and the mill will be enlarged to a capacity of upwards of 250 tons daily. President Harry Oakes estimates the value of ore in sight at $6,000,000. The Teck-Hughes largely increased its output during September, the value being well over $100,000. Some of the ore treated contained about $40 per ton, millheads averaging $30 for some days in succession. A new vein at the 700 ft. level has proved to be one of the richest and most consistent found in the district. The main shaft is being sunk to the 1,000 ft. level. The Wright-Hargreaves milled an average of 200 tons per day during August, being the highest tonnage record of any mill in the district. The company has declared a 5% dividend, bringing the total amount of dividends paid during the year up to $412,500. The shaft will be put down from the 700 ft. to the 1,000 ft. level. Larger equipment is being installed at the Sylvanite, including a new hoist, which will enable the workings to be extended to lower levels. Rich ore has been encountered at the 400 ft. level of the Burnside section of the Kirkland Lake Proprietary (1919). Native gold and gold tellurides are in evidence, and the mineralization extends over a width of from 4 to 6 ft. Operations of the King Kirkland were interfered with by a heavy flow of water, but the difficulty has been overcome. A new vein over 6 ft. wide has entered the shaft. A new vein on the property of the Crown Reserve in the eastern part of the district carries visible gold and shows a width of 8 ft. At the Goodfish the shaft is down 180 ft., and two veins, 15 and 20 in. wide, have been encountered. Cross-cutting at the 600 ft. level of the Bidgood has tapped two veins, one 4 and the other 8 ft. in width.

COBALT.—Early in October the country in the immediate neighbourhood of Cobalt and the outlying silver camps was visited by disastrous bush fires, which caused much loss of life and property, and completely destroyed the towns of Haileybury and North Cobalt and several villages. The town of Cobalt narrowly escaped destruction. Mining losses were confined to a few isolated prospects.

The Nipissing during August mined ore of an estimated net value of $189,258, and shipped bullion and residue of an estimated net value of $394,406. More recent shipments included two carloads of residue which were consigned to a pottery firm in Berlin, Germany, who will use the cobalt content for colouring purposes. The annual report of the Kerr Lake for the year ended August 31 shows a total income of $133,015, and a deficit after the payment of dividends, etc., of $560,383, as compared with a deficit of $560,325 for the previous year. The total surplus was $1,016,258. The O'Brien is planning to extend exploration work to the east side of Cross Lake, where the company holds some claims on which a strong calcite vein occurs. At the Colonial the shaft is down 270 ft. and will be continued to 800 ft. or deeper. The Oxford Cobalt has encountered a blind vein carrying niccolite and good silver content. Cross-cutting is being undertaken on the 450 ft. level of the Genessee to reach the downward continuation of a rich vein encountered on an upper level. The Coniagas has installed a mining plant on the

Ruby property in Bucke Township, and is commencing exploration and development.

RED LAKE.—A new silver field has been discovered at Red Lake in the Patricia district near the Manitoba boundary. The announcement of the finding of silver was followed by the usual rush of prospectors and speculators, and a large area has been staked. The principal minerals are stated to be stephanite, carrying 68% silver, and galena, generally silver-bearing. Native silver is also stated to occur.

VANCOUVER, B.C.

October 9.

PORTLAND CANAL DISTRICT. — The Premier Gold Mining Co. distributed another $750,000 dividend for the quarter ended September 30, bringing the distribution for the year ended on that date up to $2,400,000. This is by far the best record that ever has been achieved by a British Columbia mining company. The Granby company in the heyday of its prosperity caused by war-time metal prices, distributed $1,499,848 in 1917 and 1918, and the Consolidated Mining & Smelting Co., under similarly favourable conditions, distributed $1,047,745 in 1918, and $1,052,743 in 1919. Both of these companies have a much larger capitalization than the Premier company, and neither of them has been able to pay dividends under the difficult conditions of the present year. In fact, the Silversmith Mines, Ltd., which paid dividends of $25,000 each for the second and third quarters of this year, is the only other mining company in the Province that has disbursed a dividend this year. The Premier company has developed a large ore reserve, sufficient, it is understood, to maintain the present rate of production for three or four years, at any rate, while the company owns or controls more than 50 claims, most of which as yet has been explored only superficially. H. A. Guess, vice-president and managing director of the company, informed me recently that since the beginning of the present year the company has been making monthly shipments of some 3,000 tons of ore averaging $80 per ton to the Tacoma smelter, 3,000 tons averaging $35 per ton to the Anyox smelter, and has been treating between three and four thousand tons in its own mill.

The Alaska Premier Mining Co., which owns claims on both sides of the international boundary, has been doing a lot of surface stripping, and has exposed three veins, the largest of which has been stripped for 35 ft. without exposing either wall. A tunnel has been started. The company is constructing a camp, and purposes to continue development during the winter.

The American Mining & Milling Co., which acquired the Fish Creek mine, on the Alaskan side of the boundary, this year, has made several small shipments of high-grade ore, which have yielded between four and six hundred dollars per ton. The road to the mine has been completed, and a considerable amount of machinery has been taken to the property, the wagons returning with high-grade ore. A good body of ore has been developed, and both high-grade and medium-grade ore will be shipped during the winter.

A. B. Trites and associates have put a large force of men on road work, in the hope of connecting the Stewart-Premier road with the Big Missouri mine before winter sets in, and if they succeed several shipments of high-grade ore will be made during the winter. This syndicate has bonded the Unicorn group recently, and has commenced to explore it.

What locally is considered to be the most important transaction since the Guggenheims obtained control of the Premier is the bonding of the George group of 20 claims by the Granby company. A considerable amount of surface stripping and trenching has been done, and three belts of ore, ranging from 4 to 50 ft. wide, have been exposed over lengths of 1,000 to 2,000 ft. up the side of the mountain. The property is situated at the head of Bear River valley, some 18 miles from Stewart, and its inaccessibility has deterred its earlier development. The Granby company will explore the property with a diamond-drill next season, and if the quality of the ore, which at the surface ranges from 3 to 16% of copper with small gold and silver values, persists at depth the mine will be opened up and worked.

WEST KOOTENAY.—The Consolidated Mining & Smelting Co. has suspended operations at its Rossland mines and has transferred the employees to the Sullivan mine. Only development work has been done at the Rossland mines since May, as fuel conditions, due to the strike in the Crow's Nest coalfields, necessitated the closing of the copper-smelting branch of the plant at Trail. As a large supply of ore has been blocked out, it is unlikely that the mines will be reopened before the concentrator, now under construction at

Kimberley, is finished. This will release the 1,000-ton concentrator at Trail, which is being used to treat the Sullivan mine ore, for the ores from the Rossland mines, and it has been demonstrated that it is far more economical to dress the Rossland ore by flotation before smelting.

During the first six months of the present year the Consolidated company has produced about 45% more lead than during the corresponding period of last year. This is due to increased activity in the Kootenays, and to the fact that the Sullivan ore is giving an increased lead and a decreased zinc content. The zinc output has remained almost the same, but the gold production, owing to cessation of production at the Rossland mines, is much less than during the first half of 1921.

Frank Woodside, of Vancouver, and associates have been opening up some high-grade gold ore at the Nip and Tuck mine, in the East Kootenay. A considerable quantity of ore has been blocked out, and two carloads are ready for shipping as soon as the road to the mine is completed. Assays are said to range between \$120 and \$560 per ton.

The Wild Horse Dredging Company has commenced work with a drag-line scraper on Wild Horse creek, the plant having just been completed at a cost of about \$60,000. The Gamble Mining Company, which has been working an adjoining claim for the last two years, has had to close work for the season, as a number of its flumes were washed out by floods following a cloud-burst. The ground has been yielding \$1·50 per cubic yard.

Boundary District.—The Consolidated Mining and Smelting Co. has closed its Rock Candy mine and mill, at Lynch creek, because of a shortage of cars, due to the railway shopmen's strike in the United States. Nearly the whole of the fluorite concentrate is marketed at Gary, Indiana. The Consolidated had entered into a contract with the steel manufacturers, and it was thought that the contract would keep the mine in operation for a year, at the least. It is expected that the mine, on which the company has expended \$250,000, will be reopened as soon as the strike is settled and cars are available.

What promises to be an important new gold strike was made recently at Hills Bar creek, near Hope, some 80 miles east of Vancouver. There are three veins, from 4 to 15 ft. wide, carrying free gold and chalcopyrite, and grab samples have assayed as high as \$1,380 in gold per ton.

Skeena and Atlin. — An important alluvial discovery is reported from Kleanza creek, near Usk, in the Skeena division. Some fifty prospectors have gone to the district, and a number of leases have been staked. The gold, which is found in the bed of the creek, is coarse, some of the nuggets weighing more than an ounce. Lode gold has been found in this district for several years, and considering the transport difficulties a considerable amount of development has been done, but this is believed to be the first discovery of alluvial gold in the district.

Timmins Brothers, the well-known Ontario mine operators, have bonded the Engineer mine, at Atlin, subject to the Privy Council upholding the decision of the Supreme Court of British Columbia, which vested the title of the mine with the heirs of the late James Alexander. Some of the richest gold ore ever found in British Columbia has been taken from the Engineer mine, and to Alexander, who operated it in the crudest way, it was an independence. In 1917 the mine was bonded to the Mining Corporation of Canada, and two of the Corporation's engineers, who made an examination of the property, together with Alexander and his wife, lost their lives in the sinking of the *Princess Sophia*, while returning from Skagway to Vancouver. Since then the mine has been almost continuously in the courts. The appeal comes up for hearing before the Privy Council in November.

CAMBORNE

November 6.

Tresavean Tin and Copper Mine.—The firm tone displayed in the tin market and the recent substantial rise in the price of the metal is causing Cornish mining to look to its guns, and there are not wanting signs of activity in new quarters. Tresavean has taken on about 100 miners who are now at work sinking Harvey's shaft and developing the lower levels. A vigorous programme of development in the bottom of the mine is being carried out, for which a sum of £30,000 is stated to have been allotted. The directors are to be congratulated on their courage in tackling this necessary work after a prolonged season of heavy expenditure in keeping the mine dry.

South Crofty.—The new 90 in. pumping engine recently installed at New Cooks Kitchen shaft had a preliminary canter on October 31, and as everything went off without a hitch, serious pumping was commenced the following day and will continue until the incoming water from East Pool and Tincroft is mastered. The contractors concerned in the dismantling of the engine at Grenville and its transport and re-erection at South Crofty are to be congratulated on their success. It is expected that work will be resumed underground at this mine early in the New Year.

Wheal Busy.—Rumour is current that Great Wheal Busy which has been idle for the last twelve years is to be re-started. The mine is to be partially drained and work commenced on ground standing below adit. Large bodies of mispickel exist, and it is on these that attention will probably be turned in the first instance. This mine was acquired by the company operating at Killifreth in 1920, and the plant which was purchased from the old Franco-Belgian Co. by Lord Falmouth was leased to them to treat the Killifreth ores. Wheal Busy was the Great Chacewater mine where James Watt installed his first improved pumping engine in Cornwall with a separate condenser in 1777; it was then considered to be the wettest mine in Cornwall.

East Pool.—The new shaft is now down about 800 ft. A hard band of greenstone is being encountered, and progress is slower than usual in consequence.

Kingsdown Mine, Hewas Water.—Foundation work in connexion with the erection of the 30-head of Californian stamps purchased from Poldice is proceeding apace. It is understood that the Minerals Separation company have been for some time past experimenting on the ores from this mine with a view to dealing with the battery pulp by their process. A very high percentage of extraction is expected judging by results obtained, and if successful on the mine the process will undoubtedly have far reaching results. Previous trials in Cornwall have not been successful for one reason or another.

South Terras, Grampound Road.—This old uranium mine so highly spoken of by the late Mr. J. H. Collins is now in full operation for the extraction of its radium. The whole of the stope fillings left by former workers are being treated and thus the waste of yesterday becomes the valuable ore of to-day. A system of dry crushing is in vogue, the ore afterwards being chemically treated for its radium content, the uranium oxide being a valuable by-product. The sandy residues, which are low in radio-activity, form a valuable manure which though not appreciated in this country has a good market on the Continent. The mine is drained to the 30-fathom level, and no doubt exploration will be carried on below this in due course.

Geevor Mine, Pendeen.—A new air-compressor is now being installed to cope with the increased demand for air, caused by the vigorous development at present carried out on the Pig and other lodes recently developed.

SOUTH AFRICA

October 17.

The Rand Position.—The industrial situation upon the Rand continues to show marked improvement. With development work nearly back to normal, working costs now average about 20s. per ton. In spite of fanciful arguments to the contrary, managers are still sending gold ore and not cheaply-quarried quartzite to the mills, and this reduction of working costs means increase of profits, now totalling the best showings for 1920. The cost reduction of 5s. per ton is equivalent to approximately 15s. per ounce of gold. Conditions are rendered solid by factors liable to make for further improvement, namely, the scope for reduced cost of stores, still 40% above pre-war figures, and for further efficiency of labour under the improved system of control. Against these factors must be placed pending charges against holiday leave, against increased development, and possibly minor re-equipment. Store and material purchases have been notoriously small, firms and agents failing to see any reflection of increased mining profits in their order books at present.

Diamonds.—The "Diamond Revival" does not appear to be anything very tangible in mining and commercial circles. Diamond production shows no marked increase and substantial orders for new stores or machinery have not been recorded. At the same time, the diamond industry has been idle for so long, that there must be considerable hesitation and delay in responding to the brighter outlook in the world's market.

New Gold Prospects on Marico River.—Further details are now coming to hand of the new gold prospects under development in the Marico River district, 100 miles north-west of Rustenberg and near the Bechuanaland border. The finds are notably upon the farms Batavia and Kameelboon, where the Ventersdorp system is exposed. The history of the gold-bearing beds hitherto known in this formation prompts extreme caution in an interpretation of reports, not as regards assay-value and width of samples, but with particular reference to data indicating absence of extreme patchiness. One report states :—" The discovery consists of auriferous conglomerate. . . . On Batavia, one of these beds, up to 3 ft. thick, has been opened for about 400 yards and to a depth of 20 ft. Assays of over 3 oz. are stated to have been obtained from samples, and general panning results easily represent an ounce. On Kameelboon, what appears to be another line of conglomerate has been opened over 300 yards, showing a 4 ft. wide reef also panning extremely well."

The well-known boulder and pebble beds of the Ventersdorp series are formed of fragments from the Witwatersrand Beds, and have frequently yielded good assays. In the old days they have been prospected, at times, in the belief that a normal conglomerate, formed in situ, had been found. For this reason, special caution in accepting the new reports is essential, until geological evidence is forthcoming in conjunction with the assay results. Meanwhile, the finds are not suffering for lack of general publicity, and reports of the new gold belt in the Northern Transvaal appear weekly in the Press throughout the country.

Visit of Tom Mann.—There has been considerable discussion as to the wisdom of the Government in permitting Tom Mann to visit South Africa to-day, with the avowed intention of preaching non-constructive revolutionary doctrines. Having attended one of his meetings, I feel convinced that no permanent harm can result from his activities and that he will merely act as a safety-valve for suppressed discontent, ultimately reducing the pressure by a futile escape of poison gas in the form of vaporous oratory. Deep dissatisfaction undoubtedly exists among a large section of the employees, who await a further opportunity to gain industrial control. But this opportunity is far away at present, and Mr. Mann's unquestionable powers of exciting the passions of his fellows will be expended without avail.

Tom Mann can never be a constructive Trade Union leader. Consistently, he is a communist and, therefore, by definition, a Red International. In this capacity, he is more likely to widen the cleavage in the ranks of Rand labour, where the moderates are gaining ground, than to strengthen and consolidate unruly forces. A policy of international communism could never find a lasting place in South African politics, where the opponents of sound constructive government are the ultra-conservative back-veld farmers on the one hand and the white labour extremists on the other. Tom Mann, judging by his initial utterances, realizes this difficulty well enough, and it is evident that he intends to stir up a fresh wave of agitation merely by wild and general anti-capitalistic denunciations. Frankly enough, he admits that Russian Bolshevism is the only tonic he has to offer, although he carefully avoids making truthful references to the condition of the people upon whom this prescription has been tried.

Labour on the Rand needs organizing on Trade Union lines, and will find more value in administrative ability than in the transient influence of this professional agitator, who has arrived eight months too late for effective results.

Concrete Pipes.—The annual meeting of the Hume Pipe Co. has revealed the varying fortune of this interesting enterprise, which has developed the manufacture and use of centrifugally-moulded reinforced-concrete piping. At one time, great expectations were expressed of revolutionary progress throughout the world owing to the introduction of this Australian invention, which certainly resulted in producing concrete pipes, up to 5 ft. in diameter, of a greater density and of stronger variety than any previously made and particularly suited to low-pressure services. The company has had severe competition and the difficulties so common to all pioneer firms to meet. Over 500 miles of Hume pipes have been sold. The applications of the process have been manifold. It must be recognized, however, that the concern has not fulfilled expectations as a financial success or rewarded its supporters.

Sheba Gold Mine.—Encouraging activity is being displayed in the reopening of the

historic Sheba mine of Barberton. Incline shaft-sinking to test the Zwartzkopje ore-body in depth will soon be commenced, and a small flotation plant, employing Minerals Separation process, is being installed.

MODDERFONTEIN EAST.—The Modder East and its mining policy have been subjected to wider and stronger criticism than is usually accorded to a Corner House concern. Some of these criticisms are extravagant; such as the contention that the "eyes of the mine are being picked out" because the yield has been over 8 dwt., while average ore reserves show 7·1 dwt. over a stoping width of 58 inches. There is evidence of keenly selective mining, but not of any extravagant "picking." Ore reserves averaged 7·1 dwt. with a pay limit as low as 5 dwt., but with costs at over 25s. (owing to transport of ore, small tonnage, and heavy development), this pay limit is too low. With a 6 dwt. pay limit, ore reserves show 8·3 dwt. over a stoping width, which, allowing for development ore and adequate sorting, would produce a yield equal to most recent results. The Modder East has been a disappointment. It is a mine of rich and poor shoots, most difficult to value. Financed without boldness, the company is now struggling under debenture indebtedness of £400,000, and shareholders are distressed and critical. A little more constructive suggestion would better meet the case. There is no property on the Rand to-day which accentuates more clearly the difficulties of the selective versus wholesale-mining policy, but the problem is not one for easy public discussion. The engineers of the company must publish their views, clearly and fully, in their official reports, illustrated by an ore-reserve plan.

RHODESIAN REFERENDUM.—A week to-day will give us the decision of Rhodesians on the vital question of future government. In spite of wonderful Press management of the case for joining the Union, local opinion favours the chance of the Responsible Government party. A factor, little discussed, but of considerable weight, turning the scale in favour of the Responsibles, is an inherent distrust in the hearts of Rhodesian mining men of the Transvaal Chamber of Mines and the "Rand magnates" as a political influence. The Rhodesian may not always be logical or convincing, but his impulses are independent and patriotic.

PERSONAL

FRANCIS ALLEN, chairman of Akim, Ltd., has left for West Africa.

R. A. ARCHBOLD is now managing the mica mines of F. F. Chrestien & Co., Domchanch, Behar, India.

C. B. BRODIGAN has left for South Africa.

Dr. DAVISON has left for South Africa, but will be returning to West Africa shortly.

HARVEY DODD has left for West Africa.

FRANCIS DRAKE is in Italy and expects to spend the winter there.

SIR THOMAS RATCLIFFE ELLIS has been elected president of the Manchester Geological and Mining Society.

W. H. GOODCHILD has returned from Canada.

PROFESSOR J. W. GREGORY has returned to Glasgow from South China.

H. W. HARDINGE has returned to the United States.

C. M. HARRIS has gone to the Federated Malay States.

DR. ARTHUR HOLMES is expected from Burma.

F. G. HUYCKE, consulting engineer to the Big Dyke Gold Mines, Ltd., Porcupine, is here on a business trip.

SYDNEY J. JENNINGS has been elected President of the American Mining Congress.

A. E. KITSON has left for West Africa.

G. F. LAYCOCK has returned to Newfoundland.

ERNEST W. LEIGHTON has resigned his position with the Mond Nickel Co., and is now managing director of the Anglo-Ural Platinum Trust Company, 6, Broad Street Place, London, E.C. 2.

G. M. MACHIMSON has returned from a visit to Spitsbergen.

W. J. McBRIDE, who was for many years metallurgist at Broken Hill South, has been appointed chief of the department at the Port Pirie smelters devoted to the roasting of concentrates for the Electrolytic Zinc Co. of Australia.

Captain A. H. MOREING is Parliamentary candidate for the Camborne Division, Cornwall.

E. F. O. MURRAY has returned to India.

F. W. PAYNE has returned from the East.

ARTHUR E. PETTIT, after being in the service of the Consolidated Gold Fields of South Africa for over 26 years, is retiring from active practice at the end of the year.

R. R. THOMPSON has been appointed professor of petroleum engineering in the Birmingham University.

J. L. VITORIA has commenced business as an importer of ores and minerals, particularly from Spain, at Ethelburga House, Bishopsgate, London, E.C. 2.

Dr. GEORGE B. WATERHOUSE has been appointed head of the metallurgical department at the Massachusetts Institute of Technology, in succession to Dr. H. O. Hofman.

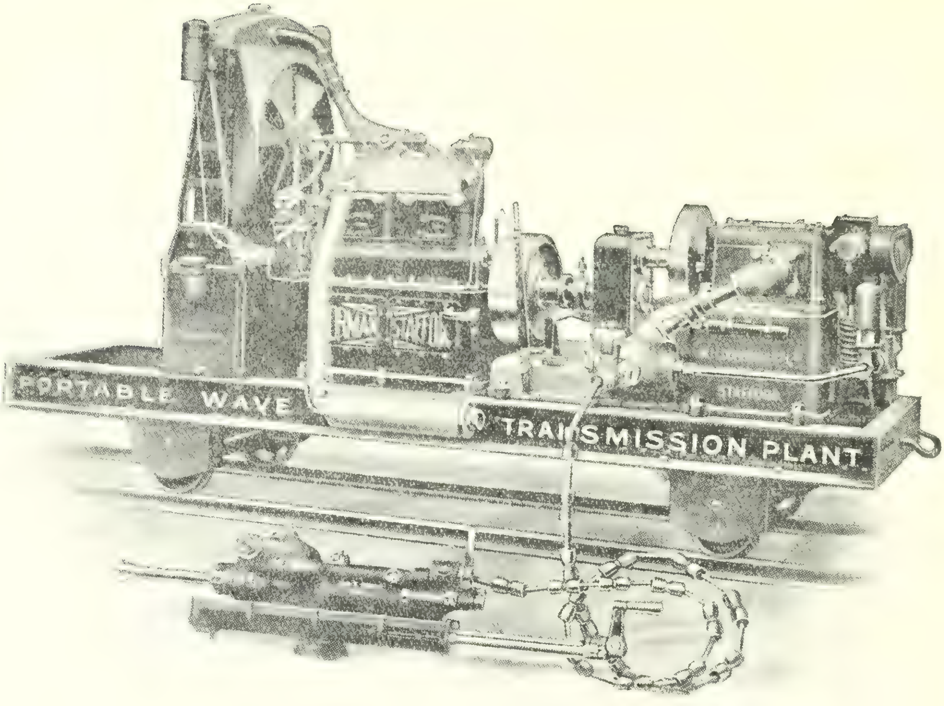
W. J. WELLINGTON is expected from India.

A. S. WHELER is home from the East.

SIR REGINALD WINGATE has been elected chairman of Tanganyika Concessions in succession to TYNDALE WHITE.

HERBERT WRIGHT has been appointed chairman of the executive committee of the governing body of the Imperial College of Science and Technology, in succession to Sir Arthur Dyke Acland. Mr. Wright is well known in connexion with the Malayan rubber industry.

H. H. YUILL has returned from Canada.



Portable Petrol Motor and Wave-Generator for Dorman Rock-Drill.

TRADE PARAGRAPHS

Padley & Venables, Ltd., of the Dominion Steel and Tool Works, Sheffield, send us copies of their List B, Sections 2 and 3. Section 2 deals with steels of all sections, solid and hollow, for rock-drills, and Section 3 is devoted to coal-cutter picks.

Hyatt, Ltd., of 56, Victoria Street, Westminster, have issued the following publications recently: Instruction card for assembling the Hyatt mine-tub wheel; Pamphlet describing the application of the Hyatt roller-bearing to iron and steel works machinery.

The Hardinge Company, of New York (London office: 11, Southampton Row, W.C. 1), have received an order for one of their largest and improved heavy-duty type of Hardinge ball-mills for shipment to Africa, for use in the comminution of quartz ore to *minus* 80 mesh at the rate of 300 tons per day. The mill will be built in England, and will be equipped with machine-cut steel gearing.

The Westinghouse Electric & Manufacturing Co., of East Pittsburgh, Pennsylvania, has put on the market an apparatus having for its object the prevention of accumulation of explosive gases. The apparatus consists of a coil of wire heated electrically and covered with a catalyst such as platinum, which being heated to a suitable temperature consumes the combustible constituents of the atmosphere without fear of an explosion. The company also sends us a publication describing its insulating and soldering compounds.

Ropeways, Ltd., of Eldon Street House, South Place, London, E.C. 2, last year built the Dorada Aerial Ropeway in Colombia. This is the longest ropeway in the world and passes over the central range of the Andes between the Magdalena and Cauca Rivers. An article on the subject with maps, working drawings, and photographs, written by G. F. Zimmer, was published in the issue of *Engineering and Industrial Management* for September 7 and 14. This gives a complete technical description of an important example of the Roe system of aerial ropeways.

Huntington, Heberlein & Co., Ltd., of 18, Iddesleigh House, Caxton Street, London, S.W. 1, send us pamphlets describing the "H.-H." Universal concentrator, which is manufactured under the Overstrom patents. The reciprocating structure is supported by laminated flexible wooden legs. Long upwardly-curved riffles are employed, so that the whole deck area becomes an effective concentrating surface. The driving mechanism consists solely of one unbalanced loose pulley driven on a shaft fixed rigidly to and across the shaking table frame, and the centrigufal force of this unbalanced weight imparts a horizontal reciprocating motion to the table.

W. H. Dorman & Co., Ltd., of Stafford (London Office: St. Bride's House, Salisbury Square, London, E.C. 4), send us particulars of the progress made in the development and application of the wave-transmission rock-drill. In this system, which is the invention of G. Constantinesco, impulses are transmitted through water by waves of compression, but as full particulars were given in the Magazine for February and March, 1921, it is not necessary here to enter into details of the construction and theory of the drills. The

accompanying illustration shows a self-contained generator set in which the power is supplied by a Dorman petrol or paraffin engine. Sets of this type have recently been supplied to the Bombay Municipality for quarry work. Similar sets for the same class of work but electrically driven have been supplied to the town of Bradford. It is to be noted that in the construction of the wave generator no castings are now employed, but high-grade steel forgings are used instead. W. N. Duff, who has conducted tests for the company to ascertain the duty and power used by this system as compared with compressed air, presents figures In each case the pipe-line was about 70 ft. in in favour of the wave-transmission rock-drill. length, and both air-compressor and wave-generator were electrically driven. The tests were on a block of Cornish granite 4 ft. thick. The times taken to penetrate the block were 13 minutes with compressed air and 6½ minutes by wave-power. It may be mentioned here that an article on the system was published in the *Engineer* for October 27 and November 3.

The General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2, send us copies of booklet No. BE. 2815, dealing with "Gecophone" receiving sets and aerial equipment for wireless broadcasting, and also Leaflet BE. 2813, giving further particulars of "Gecophone" double head-gear telephone receivers for wireless telegraphy. These pamphlets show that a range of equipment has been produced which not only complies in all respects with the regulations affecting wireless broadcasting, but is also of the simplest possible design. Simplicity is the keynote of all the "Gecophone" sets and equipment, which is noticeably devoid of technical complications and can be installed and operated with the utmost ease. Three standard complete receiving sets are at present listed, two of these being crystal sets, and the third a two-valve set. The lists also contain particulars of tuner panels and valve detector panels, two standard complete post-office aerial equipments and also component parts for making up aerial equipment. Other details, such as spare "Gecophone" double headgear telephone receivers, valves, crystals, accumulators, and high-tension batteries are also listed and the booklet also contains practical instruction for the erection of the "Gecophone" masts and aerial equipment.

Vickers, Limited, of Vickers House, Westminster, report that after a period of stagnation in the shipbuilding and marine engineering industry at Barrow-in-Furness, unprecedented as regards the dearth of orders in the history of the town, they have succeeded in the face of very keen competition in securing new work for their Barrow establishment in the form of a first-class passenger liner of approximately 20,000 tons measurement for the Orient Line. The Barrow Works of Vickers, Limited, have in the past been the cradle of many of the finest and most famous naval and mercantile ships which the world has seen. The name of Vickers is almost household where naval shipbuilding of the very highest class is concerned. The splendid workmanship for which Vickers, Limited, have become justly famous is equally demonstrated in their production of ships for the mercantile marine, and there is no doubt whatever that the Orient Liner which they have now contracted to build will when completed worthily uphold the great traditions of the Vickers firm. The combination of effort by a great shipping concern like the Orient Steam Navigation Co., Ltd., and a shipbuilding firm of the world-wide reputation which Vickers, Limited, have acquired, must result in the building of a ship of the very highest class. The propelling machinery will be turbines, driving through single-reduction gearing, and the boilers will be arranged for oil fuel. When completed, the vessel will be a handsome addition to the already fine fleet of ships operated by the Orient Line and will take up service between Great Britain and Australia—a further link connecting the Homeland with its most distant outpost of Empire. As is well known, the unemployment problem at Barrow as a result of the Washington conference decisions has been a very serious one, and the fact that Vickers have secured this important work for their highly skilled employees will considerably alleviate the situation.

METAL MARKETS

Copper.—The standard copper market in London underwent little pronounced movement during October, fluctuations in prices being restricted. On balance, prices closed rather lower on the month, which seemed to be fairly indicative of the less buoyant sentiment in the market. The chief factor at work in the standard market was the London-New York exchange, sterling prices being appreciably influenced by the trend of the dollar. General conditions affecting the position of the metal itself swayed the market but little, there being indeed hardly any fresh development of note in the situation. A fair daily business took place as a general rule on the London market, but some of the interest taken appeared to emanate from professional quarters. Home consuming demand was none too lively, and although on the Continent France and Italy were buyers, Germany was so badly hit by the latest fall in the mark exchange that she had to restrict her purchases both in London and New York. It was encouraging to note, however, that India displayed more interest in those descriptions of metal of which she is a customary buyer. Meantime, the position in the United States did not show any marked strength, and toward the end of the month sentiment on that side began to get a little apprehensive of the expanding tendency of output in South America, it being realized that this factor might upset the control which North American producers had reckoned upon retaining over the market.

Average price of cash standard copper: October, 1922, £62 16s. 5d.; September, 1922, £63 3s. 4d.; October, 1921, £67 8s. 1d.; September, 1921, £68 0s. 11d.

Tin.—The dull conditions which had ruled on the standard tin market previously were replaced during October by a state of remarkable firmness. The reappearance of America as a substantial buyer was the initial cause of the upward movement, and certain professional interests in London were not slow in taking advantage of the more optimistic sentiment on 'Change to push values up. An advance of no less than £20 per ton was actually recorded during the period under review. Towards the end of the month, American inquiry tended to slacken off, but despite this values continued to advance, with the result that a certain amount of distrust was engendered among the more cautious-minded. A pretty good Continental demand

LONDON DAILY METAL PRICES: OFFICIAL CLOSING

Copper, Lead, Zinc, and Tin per Long Ton

COPPER

	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
Oct.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
11	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 0 0 to 71 10 0	71 5 0	— —
12	62 2 6 to 62 5 6	62 15 0 to 62 17 6	70 10 0 to 71 0 0	71 0 0	— —
13	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 0 0 to 71 10 0	71 10 0	66 0 0 to 68 0 0
16	62 12 6 to 62 15 0	63 5 0 to 63 7 6	71 0 0 to 71 15 0	71 15 0	— —
17	62 10 0 to 62 12 6	63 2 6 to 63 5 0	71 0 0 to 71 15 0	71 15 0	66 0 0 to 68 0 0
18	62 5 0 to 62 7 6	62 15 0 to 62 17 6	70 10 0 to 71 0 0	71 0 0	— —
19	62 0 0 to 62 5 0	62 15 0 to 62 17 6	70 0 0 to 70 10 0	70 10 0	— —
20	61 17 6 to 62 0 0	62 12 6 to 62 15 0	70 0 0 to 70 10 0	70 10 0	65 0 0 to 67 0 0
23	62 10 0 to 62 12 6	63 5 0 to 63 7 6	70 5 0 to 70 15 0	70 15 0	— —
24	63 0 0 to 63 5 0	63 12 6 to 63 17 6	70 5 0 to 70 15 0	70 15 0	65 0 0 to 67 0 0
25	62 17 6 to 63 0 0	63 10 0 to 63 12 6	70 5 0 to 70 15 0	70 15 0	— —
26	62 15 0 to 62 17 6	63 7 6 to 63 10 0	70 5 0 to 70 15 0	70 15 0	— —
27	62 12 6 to 62 17 6	63 7 6 to 63 10 0	70 5 0 to 70 15 0	70 15 0	65 0 0 to 67 0 0
30	63 2 6 to 63 5 0	63 15 0 to 64 0 0	70 5 0 to 70 15 0	70 15 0	—
31	63 0 0 to 63 2 6	63 12 6 to 63 15 0	70 5 0 to 70 15 0	70 15 0	65 0 0 to 67 0 0
Nov.					
1	62 17 6 to 63 0 0	63 12 6 to 63 15 0	70 5 0 to 70 15 0	70 15 0	— —
2	62 15 0 to 62 17 6	63 10 0 to 63 12 6	70 5 0 to 70 15 0	70 15 0	— —
3	62 12 6 to 62 15 0	63 10 0 to 63 12 6	70 0 0 to 70 10 0	70 10 0	65 0 0 to 67 0 0
6	63 5 0 to 63 7 6	64 0 0 to 64 2 6	70 0 0 to 70 10 0	70 10 0	— —
7	63 10 0 to 63 12 6	64 5 0 to 64 7 6	70 10 0 to 71 0 0	71 0 0	65 10 0 to 67 10 0
8	63 2 6 to 63 5 0	63 17 6 to 64 0 0	70 10 0 to 71 0 0	71 0 0	— —
9	63 5 0 to 63 7 6	64 2 6 to 64 5 0	70 10 0 to 71 0 0	71 0 0	— —

manifested itself during October, and domestic buying was also not entirely negligible, thanks to the rather better feeling among tinplate makers in Great Britain. The East sold fairly steadily, the quantities disposed of increasing as prices rose, and interests out there had apparently adopted the maxim "make hay while the sun shines." It is worthy of note that the price which ruled at the end of October was some pounds above the figure at which the Federated Malay States Government had written down its large unliquidated holdings; so that sales on that account are a possibility of the near future. It remains to be seen whether the state of world demand and world production justify the higher prices now obtaining; and doubtless the answer to this query will be available as soon as the market has an opportunity to weigh up the situation once more.

Average price of cash standard tin: October, 1922, £170 12s. 4d.; September, 1922, £160 2s. 8d.; October, 1921, £156 10s.; September, 1921, £156 17s. 6d.

LEAD.—Prices fluctuated considerably during the month. A preliminary advance was followed by a reaction, so that prices were intrinsically unaltered on the 20th. A sharp upward rise then set in, but the strength was not maintained, and the closing days witnessed a renewed decline. Prices moved more or less inversely with the volume of fresh supplies, the setback in the middle of the month being directly attributable to unexpectedly large shipments from Mexico. Holders maintained quite a deal of control over the market, as was indicated by the expansion in the backwardation from 12s. 6d. to 30s., and were assisted in their firm attitude by the good scale of consuming demand. The future of values must depend largely on the size of future shipments from producing countries. It is not anticipated that Australia or Spain will be able to send very much larger supplies in the near future, but it would not be at all surprising if Mexico plays an increasingly important rôle as a producer and exporter.

Average price of soft foreign lead: October, 1922, £25 1s. 3d.; September, 1922, £23 16s. 3d.; October, 1921, £23 10s. 8d.; September, 1921, £22 19s. 5d.

SPELTER.—Noteworthy strength was displayed by the spelter market during October, the main features being a reviving tendency in the galvanizing industry and a continuance of the tight condition of supplies. The previous steady rise in values had apparently alarmed consumers, who began to buy to cover their requirements, and this brought about still further firmness. Toward the end of the month, America came into the market as a seller—somewhat unexpectedly—doubtless having been attracted by the high level of London quotations; and this caused a partial relapse. The United States does not appear to have much metal to spare, however, and it is very doubtful whether that country will be able to make further sales here on any big scale just yet. Ultimately the high ruling quototions must tend to cause world production to expand, but no immediate relief is in sight, makers being firm in their ideas everywhere. At the end of the month the backwardation was considerable, prompt delivery commanding a premium of about £2 over forward.

Average price of spelter: October, 1922, £34 0s. 6d.; September, 1922, £31 8s. 8d.; October, 1921, £26 10s. 7d.; September, 1921, £25 10s. 8d.

ZINC DUST.—The advance in spelter has hardened prices, which are now as follow: Australian high-grade £52 10s, American 92 to 94% £50, English 90 to 92% £50 per ton.

ANTIMONY.—English regulus is steady at £27 to £29 10s. per ton for ordinary brands, and £33 15s. to £35 for special brands. Foreign material is steady with metal in warehouse quoted at £25 to £26; for shipment from the East business is possible at rather under these figures.

ARSENIC.—A better demand on short supplies has forced the price up to about £53 per ton, delivered London, for Cornish white.

BISMUTH.—The market is steady at 10s. per lb. for 5 cwt. lots and over.

CADMIUM.—A small but steady business is passing at about 5s. 6d. per lb.

PRICES ON THE LONDON METAL EXCHANGE.
Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc Spelter	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Oct.
25 2 6 to 24 0 0	26 10 0	32 13 9 to 32 0 0	165 17 6 to 166 0 0	167 2 6 to 167 5 0	34 13/16	34 13/16	93 0	11
25 2 6 to 24 2 6	26 10 0	32 16 3 to 32 3 9	166 5 0 to 166 7 6	167 10 0 to 167 12 6	34⅝	34 [illegible]	93 0	12
25 5 0 to 24 5 0	26 10 0	33 2 6 to 32 10 0	167 12 6 to 167 15 0	168 12 6 to 168 15 0	34⅜	34⅜	93 0	13
25 10 0 to 24 8 9	26 15 0	33 15 0 to 32 17 6	168 17 6 to 169 0 0	170 0 0 to 170 2 6	34 1/16	33 15/16	92 10	16
25 7 6 to 24 7 6	26 15 0	34 2 6 to 33 2 6	169 7 6 to 169 10 0	170 10 0 to 170 12 6	33⅞	33¾	92 10	17
25 5 0 to 24 5 0	26 10 0	34 7 6 to 33 7 6	171 0 0 to 171 2 6	171 15 0 to 171 17 6	34 [illegible]	34 [illegible]	92 5	18
25 0 0 to 24 5 0	26 5 0	35 2 6 to 34 2 6	172 5 0 to 172 7 6	173 5 0 to 173 7 6	33 [illegible]	33 [illegible]	92 0	19
24 15 0 to 24 7 6	26 5 0	35 15 0 to 34 5 0	171 15 0 to 171 17 6	172 15 0 to 172 17 6	33¾	33⅝	92 3	20
25 10 0 to 24 15 0	26 10 0	35 17 6 to 34 15 0	173 5 0 to 173 7 6	174 2 6 to 174 5 0	33 [illegible]	33¾	92 5	23
26 10 0 to 25 5 0	27 10 0	36 2 6 to 34 15 0	174 7 6 to 174 10 0	175 2 6 to 175 5 0	34 [illegible]	34	92 7	24
26 17 6 to 25 10 0	28 5 0	36 10 0 to 35 5 0	176 15 0 to 176 17 6	177 10 0 to 177 12 6	34 [illegible]	34⅛	92 9	25
27 0 0 to 25 10 0	28 5 0	37 10 0 to 36 0 0	177 7 6 to 177 10 0	178 2 6 to 178 5 0	34 [illegible]	33¾	92 10	26
26 10 0 to 25 0 0	28 5 0	37 0 0 to 35 10 0	180 10 0 to 180 15 0	181 5 0 to 181 7 6	34⅛	33¾	92 8	27
26 10 0 to 25 0 0	27 15 0	37 0 0 to 35 0 0	184 10 0 to 184 12 6	185 0 0 to 185 2 6	34 [illegible]	33 [illegible]	92 5	30
26 17 6 to 25 7 6	28 0 0	37 7 6 to 35 10 0	184 0 0 to 184 2 6	184 10 0 to 184 12 6	33 [illegible]	33 11/16	92 6	31
								Nov.
26 0 0 to 24 15 0	27 10 0	37 5 0 to 35 7 6	180 5 0 to 180 7 6	180 15 0 to 180 17 6	33 [illegible]	33 11/16	92 5	1
25 12 6 to 24 12 6	27 5 0	37 2 6 to 35 7 6	179 2 6 to 179 5 0	179 17 6 to 180 0 0	34	33¾	92 4	2
26 0 0 to 24 15 0	27 5 0	37 10 0 to 35 10 0	183 15 0 to 183 17 6	184 5 0 to 184 7 6	33 [illegible]	33 [illegible]	92 3	3
26 0 0 to 24 17 6	27 5 0	37 15 0 to 35 15 0	187 7 6 to 187 10 0	187 15 0 to 187 17 6	34 [illegible]	33 [illegible]	92 5	6
26 2 6 to 25 2 6	27 10 0	37 15 0 to 35 17 6	184 15 0 to 184 17 6	185 5 0 to 185 7 6	33⅞	33 [illegible]	92 6	7
26 7 6 to 25 7 6	27 15 0	38 0 0 to 36 0 0	180 17 6 to 181 0 0	181 10 0 to 181 12 6	33 [illegible]	33 [illegible]	92 6	8
26 10 0 to 25 7 6	27 15 0	37 17 6 to 36 15 0	184 10 0 to 184 15 0	185 0 0 to 185 5 0	33 [illegible]	33	92 2	9

ALUMINIUM.—Demand is only moderate, the present quotations being in the neighbourhood of £95 10s. per ton for home and export. Continental material is down to about £80 f.o.b.

NICKEL.—Prices continue downward, the present quotation being £137 10s. per ton for home and export.

COBALT METAL.—There is not much business moving, and good orders can be placed at lower figures than the official price of 12s. per lb.

COBALT OXIDES.—A good demand continues and prices are firm at 9s. per lb. for black and 10s. per lb. for grey.

PLATINUM.—The market has eased off a little, with manufactured metal about £21 to £23 per oz. and sponge about £20.

PALLADIUM.—Only small parcels have been changing hands latterly, manufactured being about £17 to £19 10s. and raw about £11 to £12 per oz.

QUICKSILVER.—Good arrivals have depressed the market further, the price being now about £12 to £12 5s. per bottle on spot.

SELENIUM.—Powder unchanged at 7s. 9d. per lb.

TELLURIUM.—The market remains quiet at 40s. per lb.

MANGANESE ORE.—Indian remains firm in the absence of supplies, quotations being about 1s. 2d. to 1s. 2½d. per unit c.i.f. Caucasian is quiet, with the price rather nominal at 1s. 2d. for ordinary grades.

CHROME ORE.—Demand has fallen off considerably, and Indian and Rhodesian 48 to 50% are quoted at about £4 to £4 2s. 6d. per ton c.i.f.

SULPHATE OF COPPER.—The quotation for home and export is £26 10s. per ton.

TUNGSTEN ORE.—Material is scarce; forward shipment is quoted at 14s. 6d. per unit c.i.f., while spot is held for about 15s.

MOLYBDENITE.—Business is dull, with spot supplies scarce. Letters of prompt shipment are inclined to wait till the price appreciates. Prices 85% MoS_2 42s. 6d. to 47s. 6d. per unit c.i.f.

SILVER.—The market had an easier tone during the month. The outlook at the beginning was uncertain, but China came forward as a seller, and India was not an eager buyer, resulting in a drop in prices. Spot bars opened at 35 7/16d., eased slightly to 35¼d. on the 5th and were steady at about this figure until the 9th, when a downward movement began, due chiefly to the closing of the Canton Mint for an indefinite period. The lowest figure of 33¾d. was reached on October 20, after which a better Indian demand stiffened the price to 34 5/16d. on the 25th. The quotation closed at 33 15/16d. on October 31.

GRAPHITE.—There is not much business passing; Madagascar, 85 to 90%, is about £12 per ton, c.i.f.

IRON AND STEEL.—No great change has taken place in the iron and steel trade, though the general demand is certainly on the upgrade. Prices all round have been maintained, that of hematite pig iron indeed being advanced, owing to the high cost of fuel brought about by continued heavy purchases for foreign markets. America has not been buying so much pig iron as previously, but there is still a good deal of iron to be shipped to that side, so that for the time being ironmasters are not anxious at the falling off in the demand from that quarter, as they will be occupied mostly for the rest of the year on current contracts. The dearness of fuel, however, prevents them from making any material increase in output. No. 3 Cleveland G.M.B. is priced at 92s. 6d. per ton. Hematite has improved on an increased demand from both home and foreign consumers, and makers have been able practically to clear up all their stocks, and there is not much to be had for prompt delivery. East Coast mixed numbers are 2s. 6d. higher than No. 3 Cleveland G.M.B. Finished iron and steel generally is gradually improving, but the orders coming in are still insufficient fully to employ the plants open. Apart from some substantial Colonial Government contracts, export markets are not doing much, while home consumers are waiting and seeing. Quoted prices are unaltered, but the competition to secure orders is keen among those makers willing to sacrifice even a small profit.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of
	Oz.	Oz.	Oz.	Gold per oz.
				s. d.
October, 1921 ...	690,348	17,477	707,825	103 0
November	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921	7,924,534	190,052	8,114,586	
January, 1922 ..				95 6
February	594,788	44,940	639,728	92 6
March ..				94 0
April	493,402	17,936	511,338	92 0
May ..	612,702	17,083	629,786	92 0
June ...	658,032	17,665	675,697	92 6
July ...	713,068	17,567	730,635	92 0
August	734,438	18,052	752,490	92 0
September.......	728,597	18,492	747,089	93 0

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1921	166,999	14,688	1,246	182,933
August 31	169,008	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,419	13,465	1,217	191,092
December 31	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169
June 30	170,464	12,117	1,211	183,792
July 31	172,886	12,371	1,211	186,468
August 31	175,054	12,270	1,219	188,543
September 30	174,565	12,000	1,234	187,799

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept., 1921....	1,997,086	36 8	25 2	11 6	1,151,127
October	2,041,581	34 4	24 9	9 7	981,597
November ..	2,007,617	34 6	24 9	9 9	978,931
December....	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922 . February .. March	1,624,333	33 10	49 0	15 2*	1,233,033*
April ...	1,414,843	31 7	24 3	7 4	519,365
May.......	1,772,793	31 4	22 8	8 8	767,533
June.....	1,882,837	31 10	22 8	9 2	862,575
July	2,077,895	31 0	21 1	9 11	1,048,727
August....	2,144,850	30 11	20 6	10 5	1,113,905

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January...	43,428	46,956	53,541
February .	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May......	46,266	48,744	53,920
June......	45,054	[illegible]	55,614
July	46,208	51,564	54,191
August....	48,740	53,200	56,037
September	45,471	52,436	55,443
October ..	47,343	53,424	
November	46,782	53,098	
December.	46,190	55,968	—
Total.	[illegible]	591,525	489,129

Transvaal Gold Outputs.

	August		September	
	Treated Tons	Yield Oz.	Treated Tons	Yield Oz.
Aurora West.. ...	11,000	£13,637*	11,900	£14,487†
Brakpan	64,000	25,941	62,000	25,727
City Deep	89,000	38,106	83,500	35,638
Cons. Langlaagte	45,200	£56,927*	47,200	£57,127†
Cons. Main Reef	53,000	19,193	53,300	19,106
Crown Mines..........	226,000	68,178	216,000	68,052
D'rb'n Roodepoort Deep	31,800	10,871	30,700	10,603
East Rand P.M........	125,000	31,580	129,000	30,216
Ferreira Deep	34,000	9,857	34,700	9,985
Geduld...........	46,800	16,480	45,000	16,494
Geldenhuis Deep .	54,650	13,788	54,181	13,588
Glynn's Lydenburg ...	3,862	£7,440§	4,285	£8,368‡
Goch	17,500	£17,477*	17,200	£17,197†
Government G.M. Areas	150,000	£292,744*	143,500	£291,485†
Kleinfontein	47,900	11,853	45,300	11,454
Knight Central........	32,500	6,472	32,000	6,620
Langlaagte Estate	51,300	£73,928*	49,700	£74,590†
Luipaard's Vlei	21,000	£21,189*	19,692	£19,520†
Meyer & Charlton	15,200	£39,524*	15,000	£39,156†
Modderfontein, New ..	112,000	52,671	110,000	52,224
Modderfontein B	62,000	33,137	61,000	32,686
Modderfontein Deep ..	44,800	24,071	43,400	23,127
Modderfontein East ...	27,000	11,747	26,600	15,007
New Unified	11,900	£11,361*	11,500	£11,278†
Nourse	48,000	15,026	45,900	14,904
Primrose	20,200	£20,732*	21,700	£22,219†
Randfontein Central ..	157,000	£209,834*	163,000	£217,034†
Robinson.............	18,300	6,049	18,000	5,883
Robinson Deep	70,500	22,955	70,100	22,628
Roodepoort United ...		—	—	—
Rose Deep	53,700	12,745	53,700	13,181
Simmer & Jack	53,700	11,659	61,300	12,966
Springs	48,000	21,477	46,000	21,324
Sub-Nigel	11,000	5,826	10,000	5,733
Transvaal G.M. Estates	16,170	£24,965§	15,850	£24,752‡
Van Ryn	34,900	£45,307*	34,000	£45,327†
Van Ryn Deep	57,200	£130,126†	56,600	£132,557†
Village Deep	57,600	18,048	58,800	18,243
West Rand Consolidated	34,300	£44,755*	34,000	£44,119†
Witw'tersr'nd (Knights)	48,000	£55,925*	46,300	£55,208†
Witwatersrand Deep ..	37,200	12,739	43,500	13,147
Wolhuter.............	32,100	7,989	32,900	7,530

* £4 12s. per oz. § £4 10s. per oz. † £4 13s. per oz. ‡ £4 11s. per oz.

Rhodesian Gold Outputs.

	August		September	
	Tons	Oz.	Tons	Oz.
Cam & Motor	15,300	5,656	15,300	6,225
Falcon	16,572	3,061‖	16,312	3,045*
Gaika..............	—	—	—	—
Globe & Phœnix	6,370	6,689	6,399	6,049
Jumbo	1,450	498	1,400	508
London & Rhodesian	2,981	£3,396	3,600	£3,478
Lonely Reef.........	5,550	4,039	5,320	4,076
Planet-Arcturus	6,100	2,660	5,900	2,296
Rezende	6,100	2,940	6,100	3,470
Rhodesia G.M. & I...	—	—	—	—
Shamva	54,950	£37,179§	57,550	£36,773‡
Transvaal&Rhodesian	1,580	£5,057†	1,560	£5,067†

* Also 292 tons copper. † At par. ‖ Also 297 tons copper.
§ Gold at £4 10s. per oz. ‡ Gold at £4 11s. per oz.

West African Gold Outputs.

	August		September	
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,710	£12,609*	7,700	£14,548*
Abosso.............	7,010	2,844	6,980	2,285
Ashanti Goldfields..	7,808	6,522	7,612	6,436
Obbuassi	513	435	562	£1,065†
Prestea Block A....	7,666	£15,207*	7,439	£15,033*
Taquah............	2,453	1,304	2,400	1,247

* At par. † Including premium.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
January, 1922.. ...	329	37,851	38,180	162,177
February.........	926	41,194	42,120	178,913
March....	180	42,842	43,022	182,745
April....	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June.......	136	49,158	49,294	209,386
July........	366	42,774	43,140	183,247
August....	1,051	48,638	49,689	211,064
September..	—	46,398	46,398	197,085
October........	216	49,092	49,308	209,446

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	Oz.	Oz.	Oz.	£
January......	38,181	4,411	448	11,855
February	42,121	8,063	1,200	12,325
March..........	43,022	11,717	1,069	12,960
April..........	46,394	4,186	6,219	6,589
May	39,725	10,089	7,636	13,100
June.........	49,294	12,058	12,181	6,784
July..........	43,140	9,966	6,906	4,907
August........	49,690	8,456	8,077	5,285
September....	—	—	—	—
October	—	—	—	—
November	—	—	—	—
December.....	—	—	—	—
Total.....	351,567	68,909	43,826	73,805

Australasian Gold Outputs.

	August		September	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)...	6,350	7,924‖	6,309	8,935‖
Blackwater (N.Z.)	3,677	7,475*	3,670	9,385*
Golden Horseshoe (W.A.).	9,708	5,450‡	9,012	5,460‡
Grt. Boulder Pro. (W.A.) .	11,678	26,850‖	11,052	26,525‖
Hampton Celebr. (W.A.) .	1,090	1,900‖	1,007	1,932‖
Ivanhoe (W.A.)...........	16,869	6,015‡	14,933	6,108‡
Lake View & Star (W.A.).	4,163	12,235*t	5,542	16,295e*
Menzies Con. (W.A.)	2,080	4,026	1,800	3,642
Oroya Links (W.A.)	2,802	15,383†‖	3,003	15,796‖†
South Kalgurli (W.A.) ...	7,446	12,437‖	7,337	12,657‖
Waihi (N.Z.)............	15,463	4,655‡ 23,081§	15,347	4,290‡ 36,805§
,, Grand Junc'n (N.Z.) ..	—	—	—	—

* Including premium ; † Including royalties ; ‡ Oz. gold ; § Oz. silver ; ‖ At par ; *t* six weeks to Aug. 15 ; *e* two months to October 15.

Miscellaneous Gold and Silver Outputs.

	August		September	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	440p	—	435p
Colombian Mining (C'lbia).	—	—	—	—
El Oro (Mexico)	35,020	177,148†	33,397	172,695†
Esperanza (Mexico).......	—	3,845e	—	1,785e
Frontino & Bolivia (C'lbia)	2,030	8,476	2,200	7,439
Keeley Silver (Canada) ..	—	80,285s	—	83,000s
Kirkland Lake (Ontario) .	—	26,600†	—	—
Mexico El Oro (Mexico) ..	13,380	300,290†	13,199	299,050†
Mining Corp. of Canada ..	7,927	158,633	8,051	173,290
New North-West (Yukon)	—	84,[illegible]†j	—	—
Oriental Cons. (Korea) ...	—	75,000†	—	75,500†
Ouro Preto (Brazil)	7,600	2,687	7,000	2,477
Plym'th Cons. (Calif'rnia)	7,400	7,510*	6,000	7,160*
St. John del Rey (Brazil)..	—	38,500*	—	38,000*
Santa Gertrudis (Mexico) .	44,202	33,295e	40,234	27,[illegible]e
Tomboy (Colorado)	17,000	76,000†	18,000	75,000†

* At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. p Oz. platinum and gold. *s* Oz. silver. *e* Profit in dollars. *j* July and August.

Nechi (Colombia) : 29 days to October 2, $14,268 from 158,566 cu. yd.

Pato (Colombia) : 32 days to October 1, $50,710 from 86,090 cu. yd. ; 16 days to October 17, $67,197 from 101,219 cu. yd.

Gold Outputs, Kolar District, India.
During September, 1922.

	Tons Ore	Oz.	Tons Tailing	Oz.	Total Oz.
Balaghat	3,700	1,914	8,800	1,091	3,005
Champion Reef	11,654	3,108	22,448	1,164	4,272
Mysore	18,350	5,911	49,580	4,611	10,522
North Anantapur ..	—	965*	1,300	121	1,086
Nundydroog	9,650	4,384	17,690	803	5,187
Ooregum	12,900	7,589	13,500	889	8,478

Total Gold Output for all India : February, 34,690 oz. ; March, 35,607 oz. ; April, 35,583 oz. ; May, 36,120 oz. ; June, 35,860 oz. ; July, 35,670 oz.

* Mill clean up.

Base Metal Outputs.

		August	Sept.
British Broken Hill ..	Tons lead carb. ore.....	600*	615‡
	Tons lead conc.	3,870*	3,680‡
	Tons zinc conc.	3,365*	3,260‡
Broken Hill Prop. ..	Tons lead conc.	1,867	4,088a
	Tons zinc conc.	6,209	12,385a
Broken Hill South	Tons lead conc.	4,469	3,976
Burma Corporation ..	Tons refined lead	3,421	3,464
	Oz. refined silver.......	368,704	360,768
Electrolytic Zinc	Tons zinc	1,943	3,995b
Fremantle Trading ..	Tons lead	449	436
Mount Lyell	Tons copper	328	1,077§
	Oz. silver	6,618	22,526§
	Oz. gold	95	337§
Mount Morgan	Tons copper	441	956†
	Oz. gold	4,811	10,895†
North Broken Hill ...	Tons lead conc.	1,720	2,300
	Tons zinc conc.	1,700	2,050
Poderosa.............	Tons copper ore	585	550
Rhodesia Broken Hill ..	Tons lead	1,895	1,500
San Francisco Mexico	Tons lead conc.	1,270	1,920
	Tons shipping ore	—	—
Sulphide Corporation	Tons lead conc.	2,350	2,247
	Tons zinc conc.	3,588	3,938
Union Minière	Tons copper	3,871	3,510
Transvaal Silver.......	Tons silver-lead bullion	402	461
Zinc Corporation.....	Tons zinc conc.	9,410	8,795
	Tons lead conc.	776	684

* Six weeks to September 9. † Eight weeks to October 17.
‡ Six weeks to October 21. § Eight weeks to October 18.
a Eight weeks to October 11. *b* Eight weeks to October 18.

Imports of Ores, Metals, etc., into United Kingdom.

		August	September
Iron Ore	Tons ..	295,360	299,387
Manganese Ore	Tons ..	29,644	49,437
Iron and Steel	Tons ..	80,113	70,553
Copper and Iron Pyrites	Tons ..	25,216	27,148
Copper Ore, Matte, and Prec.	Tons ..	4,199	9,455
Copper Metal	Tons ..	7,757	6,939
Tin Concentrate	Tons ..	3,554	3,228
Tin Metal	Tons ..	1,495	1,733
Lead, Pig, and Sheet	Tons ..	14,645	17,030
Zinc (Spelter)	Tons ..	8,944	7,308
Zinc Sheets, etc.	Tons ..	1,069	943
Quicksilver	Lb.....	61,290	90,251
Zinc Oxide	Tons ..	502	474
White Lead	Cwt....	8,496	9,835
Red and Orange Lead	Cwt....	2,206	3,629
Barytes, ground	Cwt....	70,909	63,237
Asbestos	Tons ..	1,874	1,221
Boron Minerals	Tons ..	1,242	2,729
Borax	Cwt....	7,399	3,003
Basic Slag	Tons ..	8,726	10,039
Phosphate of Lime	Tons ..	17,569	44,856
Mica	Tons ..	124	109
Sulphur	Tons ..	3,615	1,377
Nitrate of Soda	Cwt....	128,681	106,755
Potash Salts	Cwt....	211,395	385,789
Petroleum : Crude	Gallons	17,927,480	13,794,239
Lamp Oil	Gallons	5,003,698	5,549,537
Motor Spirit	Gallons	29,107,464	17,743,294
Lubricating Oil	Gallons	4,939,937	6,464,467
Gas Oil	Gallons	5,527,994	1,513,088
Fuel Oil	Gallons	52,477,736	26,268,789
Asphalt and Bitumen	Tons ..	11,[illegible]	12,247
Paraffin Wax	Cwt....	92,508	95,647
Turpentine	Cwt....	34,385	25,921

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	July	August	September
Nigeria:	Tons	Tons	Tons
Bisichi	34	40	34½
Ex-Lands	30	30	30
Filani	1½	2¼	3
Gold Coast Consolidated	—	—	—
Gurum River	7	8	9
Jos	11½	12¼	10½
Kaduna	3½	3¼	4¼
Kaduna Prospectors	6½	3½	7¾
Keffi Consolidated	20	20	20
Lower Bisichi	9¼	10½	12¾
Mongu	30	30	30
Naraguta	50	50	50
Naraguta Extended	26	27	27
Nigerian Consolidated	9	9	15
N.N. Bauchi	60	60	69
Rayfield	40	40	40
Ropp	111	102	108
Rukuba	2	2½	3
South Bukeru	5	5	7
Tin Fields	8	8	8
Yarde Kerri	3	3	4
Federated Malay States:			
Chenderiang	—	—	88*
Gopeng	68½	53½	65½
Idris Hydraulic	20¾	17¼	19½
Ipoh	18½	16	21¼
Kamunting		—	106*
Kinta	32¼	30	30
Lahat	34	32¾	32½
Malayan Tin	92¼	86¼	95¼
Pahang	200	205	180
Pengkalen	—	12	—
Rambutan	21	18	18
Sungei Besi	50	54	54
Tekka	36	31	39
Tekka-Taiping	12½	9½	20
Tronoh	78¼	71	67½
Other Countries:			
Aramayo Mines (Bolivia)	225	200	211
Berenguela (Bolivia)	41	36	37
Briseis (Tasmania)	—	—	23
Deebook Ronpibon (Siam)	21	30	27
Leeuwpoort (Transvaal)	—	—	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	35½	68	60½
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	125	90½	81½
Tongkah Harbour (Siam)	93	83	91
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note.—These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	667	678	613	547	438	473
February	646	668	623	477	370	412
March	655	707	606	505	445	[illegible]
April	555	584	546	467	394	434
May	509	525	[illegible]	383	337	[illegible]
June	473	492	484	435	423	[illegible]
July	479	545	481	484	494	[illegible]
August	551	571	616	447	477	[illegible]
September	538	520	561	528	595	492
October	578	491	625	628	546	
November	[illegible]	472	536	544	564	
December	[illegible]	518	511	577	555	
Total	[illegible]	6,771	[illegible]	6,022	5,618	[illegible]

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,035	3,765	4,265	3,298	3,143
February	3,197	2,734	3,014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	2,909
July	3,373	3,756	2,824	2,734	3,086
August	3,259	2,956	2,786	3,051	3,001
September	3,157	3,161	2,734	2,338	2,890
October	2,870	3,221	2,837	3,161	—
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	26,440

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	Aug. 31	Sept. 30	Oct. 31
Straits and Australian Spot	2,694	2,714	2,234
Ditto, Landing and in Transit	225	25	100
Other Standard, Spot and Landing	4,195	4,383	3,901
Straits, Afloat	1,025	455	370
Australian, Afloat	75	125	125
Banca, in Holland	2,624	2,573	2,453
Ditto, Afloat	735	891	50
Billiton, Spot	27	14	—
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	650	450	800
Total Afloat for United States	6,697	7,622	7,083
Stock in America	2,806	1,236	2,859
Total	21,753	20,488	19,975

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long Tons.

	Aug.	Sept.	Oct.
Shipments from:			
Straits to U.K.	1,060	250	375
Straits to America	4,160	3,350	4,450
Straits to Continent	635	450	825
Straits to other places	125	250	150
Australia to U.K.	25	150	128
U.K. to America	50	75	350
Imports of Bolivian Tin into Europe	1,640	1,394	2,812
Supply:			
Straits	4,035	4,050	5,650
Australian	50	150	128
Billiton	—	—	—
Banca	846	1,760	360
Standard	684	928	1,686
Total	5,615	6,888	7,824
Consumption:			
U.K. Deliveries	2,420	1,770	1,315
Dutch ,,	313	548	634
American ,,	4,590	5,050	5,603
Straits, Banca & Billiton, Continental Ports, etc.	486	785	785
Total	7,809	8,153	8,337

Imports and Exports of Gold and Silver.

During September, 1922.

		Imports	Exports.
Gold:	Unrefined Bullion £	457,633	—
	Refined Bars ,,	2,607,235	2,436,512
	Coin ,,	6,748	172,253
Silver:	Unrefined Bullion oz.	1,112,371	—
	Refined Bar ,,	1,175,533	3,200,990
	Coin £	323,422	246,713

Outputs Reported by Oil-producing Companies.
In Tons.

	July	August	Sept.
Anglo-Egyptian	8,607	19,195	17,082
Anglo-Texas	1,904	1,784	—
Anglo-United	—	—	—
Apex Trinidad	7,300	11,900	11,000
Astra Romana	32,542	33,210	32,365
British Burmah	10,202	9,989	9,390
Caltex	9.737	10,484	4,258
Dacia Romana	786	1,107	278
Indo-Burma	—	—	—
Kern River	13,394	13,372	13,197
Lobitos	8,845	9,371	9,092
Phœnix	5,830	3,250	3,050
Romana Americana	18,145	16,890	15,627
Roumanian Consolidated	1,617	1,504	1,751
Santa Maria	1,471	1,453	—
Steaua Romana	19,170	20,680	21,632
Trinidad Leaseholds	8,600	9,500	10,200
United of Trinidad	4,683	5,376	4,224

Quotations of Oil Companies' Shares.
Denomination of Shares £1 unless otherwise noted.

	Oct. 5, 1922			Nov. 6, 1922		
	£	s.	d.	£	s.	d.
Anglo-American	5	0	0	4	10	0
Anglo-Egyptian B.	1	14	0	1	7	6
Anglo-Persian 1st Pref.	1	4	9	1	3	6
Apex Trinidad	2	2	6	2	3	9
British Borneo (10s.)		11	3		11	3
British Burmah (8s.)		11	3		10	0
Burmah Oil	5	12	6	5	5	0
Caltex ($1)		1	3		1	6
Dacia Romano		15	0		11	3
Kern River, Cal. (10s.)	1	0	0		19	0
Lobitos, Peru	5	15	0	5	10	0
Mexican Eagle, Ord. ($5)	2	17	6	2	12	6
,, ,, Pref. ($5)	2	13	9	2	10	0
North Caucasian (10s.)		15	0		13	9
Phœnix, Roumania	1	6	0	1	7	0
Roumanian Consolidated		3	9		13	6
Royal Dutch (100 gulden)	39	10	0	36	10	0
Scottish American		1	6		1	0
Shell Transport, Ord.	4	10	0	4	2	6
,, ,, Pref. (£10)	9	10	0	9	10	0
Trinidad Central	1	18	9	1	13	9
Trinidad Leaseholds	1	5	0	1	3	9
United British of Trinidad		8	9		8	9
Ural Caspian		15	0		12	0
Uroz Oilfields (10s.)		9	6		8	0

Petroleum Products Prices. November 8.

Refined Petroleum: Water white, 1s. per gallon; standard white, 11d. per gallon; in barrels 3d. per gallon extra.

Motor Spirit: In bulk: Aviation spirit, 2s. 1d. per gallon; No. 1, 1s. 9d. per gallon; No. 2, 1s. 7d. per gallon.

Fuel Oil: Furnace fuel oil, £3 5s.; Diesel oil, £4 2s. 6d. per ton.

American Oils: Best Pennsylvania crude at wells, $3·00 per barrel. Refined standard white for export in bulk, 7·50 cents per U.S. gallon; in barrels 13·75 cents. Refined water white for export in bulk, 8·50 cents per U.S. gallon; in barrels 14·75 cents.

Dividends Declared by Mining Companies.
During month ended October 10.

Company	Par Value of Shares	Amount of Dividend
Aramayo Mines	25 fr.	10%
Burmah Oil	Ord. £1	10% tax paid.
El Oro	£1	1s. tax paid.
Gold Coast Amalgamated	£1	2½% less tax.
Gold Fields Rhodesia	10s.	6d. less tax.
Golden Horse-Shoe	£5	2s. 6d. tax paid.
Great Boulder	2s.	6d. tax paid.
Lonely Reef	£1	15% less tax.
Premier Diamond	Pref. 5s.	6s. 3d. less tax.
St. John del Rey	Ord. £1	9d. less tax.
	Pref. £1	1s. tax paid.
Scottish Australian	£1	2½% less tax.
Union Corporation	12s. 6d.	1s.
Waihi Gold	10s.	1s. tax paid.
Zinc Corporation	Pref. £1	2s. less tax.

PRICES OF CHEMICALS. November 6.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	0
,, 80%	,,	2	0	0
,, Glacial	per ton	65	0	0
Alum	,,	14	0	0
Alumina, Sulphate	,,	10	10	0
Ammonia, Anhydrous	per lb.		1	6
,, 0·880 solution	per ton	23	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	35	0	0
,, ,, pure	per cwt.	3	5	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	65	0	0
,, Sulphate	,,	16	0	0
Antimony, Tartar Emetic	per lb.		1	5
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	50	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			7
,, Chloride	per ton	20	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		1	10
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	13	0	0
,, Liquor, 7%	,,	4	10	0
Borax	,,	29	0	0
Boric Acid Crystals	,,	60	0	0
Calcium Chloride	,,	6	10	0
Carbolic Acid, crude 60%	per gal.		2	0
,, ,, crystallized, 40°	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		2	2
Copper Sulphate	per ton	27	0	0
Cyanide of Sodium, 100%	per lb.			9½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	7	10	0
,, Sulphate	,,	2	10	0
Lead, Acetate, white	,,	38	0	0
,, Nitrate	,,	44	0	0
,, Oxide, Litharge	,,	35	0	0
,, White	,,	42	0	0
Lime, Acetate, brown	,,	8	10	0
,, ,, grey 80%	,,	14	10	0
Magnesite, Calcined	,,	12	0	0
Magnesium, Chloride	,,	8	0	0
,, Sulphate	,,	8	0	0
Methylated Spirit 64° Industrial	per gal.		2	8
Nitric Acid, 80° Tw.	per ton	25	0	0
Oxalic Acid	per lb.			8
Phosphoric Acid	per ton	32	0	0
Potassium Bichromate	per lb.			6½
,, Carbonate	per ton	28	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	11	0	0
,, Hydrate (Caustic) 90%	,,	29	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			8
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	3
,, Sulphate, 90%	per ton	15	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate, 45%	,,	34	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			5
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			3
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	11	0	0
,, Nitrate, 96%	,,	13	0	0
,, Phosphate	,,	15	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	5	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salts)	,,	4	10	0
,, Sulphide	,,	18	0	0
,, Sulphite	,,	10	0	0
Sulphur, Roll	,,	8	10	0
,, Flowers	,,	9	0	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 30%	,,	3	10	0
Tartaric Acid	per lb.		1	3
Turpentine	per cwt.	5	18	0
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	0
Zinc Chloride	per ton	20	[illegible]	0
Zinc Oxide	,,	45	[illegible]	0
Zinc Sulphate	,,	13	[illegible]	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

	Nov. 7, 1921 £	s.	d.	Nov. 6, 1922 £	s.	d.
RAND:						
Anglo American Corporation	1	0	0	1	6	3
Brakpan	2	10	0	3	0	0
Central Mining (£8)	6	0	0	9	5	0
City & Suburban (£4)		2	6		3	0
City Deep	2	5	0	2	18	9
Consolidated Gold Fields		15	0	1	0	0
Consolidated Langlaagte		12	6		17	6
Consolidated Main Reef		9	6		13	0
Consolidated Mines Selection (10s.)		14	0		18	0
Crown Mines (10s.)	1	15	0	3	5	0
Daggafontein		2	6		3	9
Durban Roodepoort Deep		5	0		14	6
East Rand Proprietary		4	6		10	9
Ferreira Deep		8	6		9	6
Geduld	2	16	3		5	0
Geldenhuis Deep		5	0		6	9
Government Gold Mining Areas	3	18	9	5	7	6
Johannesburg Consolidated	1	1	3	1	11	0
Kleinfontein		5	3		8	6
Knight Central		4	6		5	0
Langlaagte Estate		11	6	1	5	0
Luipaards Vlei		3	0		4	0
Meyer & Charlton	4	0	0	3	17	6
Modderfontein, New (10s.)	3	13	9	4	7	6
Modderfontein B (5s.)	1	6	3	1	15	0
Modderfontein Deep (5s.)	2	3	9	2	8	9
Modderfontein East		9	0		9	0
New State Areas	1	2	6	1	15	0
Nourse		9	0		18	0
Rand Mines (5s.)	2	1	3	3	2	6
Randfontein Central		10	0		17	0
Robinson (£5)		9	0		11	6
Robinson Deep A (1s.)		8	9	1	16	3
Rose Deep		13	0		16	6
Simmer & Jack		2	6		5	0
Springs	1	18	9	3	12	6
Sub-Nigel		10	0		10	0
Union Corporation (12s. 6d.)		14	6	1	3	3
Van Ryn		12	0		14	6
Van Ryn Deep	3	8	9	3	14	6
Village Deep		8	0		18	0
West Springs		11	3		17	3
Witwatersrand (Knight's)		12	6		18	0
Witwatersrand Deep		8	0		18	9
Wolhuter		4	3		3	6
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		8	9		15	0
Transvaal Gold Mining Estates		8	0		10	9
DIAMONDS IN SOUTH AFRICA:						
Consolidated of S.W.A.		—		1	3	3
De Beers Deferred (£2 10s.)	10	17	6	13	0	0
Jagersfontein	2	5	0	3	12	6
Premier Deferred (2s. 6d.)	5	0	0	6	10	0
RHODESIA:						
Cam & Motor		10	0	1	4	3
Chartered British South Africa		10	9		12	6
Falcon		4	9		5	6
Gaika		10	3		11	6
Glove & Phœnix (5s.)		12	6		11	9
Gold Fields Rhodesian (10s.)		6	3		6	6
Lonely Reef	2	3	9	1	18	9
Rezende	3	5	0	3	0	0
Shamva	1	10	0	1	8	9
WEST AFRICA:						
Abbontiakoon (10s.)		2	3		2	0
Abosso		6	6		8	0
Ashanti (4s.)		13	9		13	3
Prestea Block A		1	9		1	0
Taquah		8	6		6	6
WEST AUSTRALIA:						
Associated Gold Mines		2	0		7	6
Associated Northern Blocks		1	9		2	3
Bullfinch		1	0		1	0
Golden Horse Shoe (£5)		11	3		15	0
Great Boulder Proprietary (2s.)		5	9		4	9
Great Fingall (10s.)		1	0			9
Hampton Celebration		3	0		1	9
Hampton Properties		4	3		8	6
Ivanhoe (£5)		18	9		16	3
Lake View Investment (10s.)		7	6		10	3
Lake View & Star (4s.)		2	3		1	3
Oroya Links (5s.)		1	3		1	0
Sons of Gwalia		3	6		2	9
South Kalgurli		8	0		8	6

GOLD, SILVER, *cont.*	Nov. 7, 1921 £	s.	d.	Nov. 6, 1922 £	s.	d.
NEW ZEALAND:						
Blackwater		2	6		6	3
Waihi	1	1	3	1	10	0
Waihi Grand Junction		7	6		7	6
AMERICA:						
British Platinum, Colombia		8	6		11	0
Camp Bird, Colorado		3	6		4	3
El Oro, Mexico		9	0		9	6
Esperanza, Mexico		13	6		11	0
Frontino & Bolivia, Colombia		6	3		10	0
Kirkland Lake, Ontario		11	3		10	0
Le Roi No. 2 (£5), British Columbia		2	6		1	6
Mexican Corporation, Mexico		—			7	6
Mexico Mines of El Oro, Mexico	3	15	0	4	17	6
Nechi (Pref. 10s.), Colombia		4	0		3	9
Oroville Dredging, Colombia	1	0	0	1	0	0
Ouro Petro, Brazil		16	3		14	6
Plymouth Consolidated, California		8	0		5	0
St. John del Rey, Brazil		15	0		18	6
Santa Gertrudis, Mexico		6	0		8	0
Tomboy, Colorado		5	0		7	6
RUSSIA:						
Lena Goldfields		7	6		8	9
Orsk Priority		5	0		5	0
INDIA:						
Balaghat (10s.)		7	0		8	3
Champion Reef (2s. 6d.)			3		6	6
Mysore (10s.)		10	6		11	6
North Anantapur		2	6		2	6
Nundydroog (10s.)		5	6		7	3
Ooregum (10s.)		11	6		13	9

COPPER:

	Nov. 7, 1921 £	s.	d.	Nov. 6, 1922 £	s.	d.
Arizona Copper (5s.), Arizona		17	6		17	6
Cape Copper (£2), Cape and India		10	0		10	0
Hampden Cloncurry, Queensland		5	0		5	0
Mason & Barry, Portugal	2	15	0	2	5	0
Messina (5s.), Transvaal		3	0		3	0
Mount Elliott (£5), Queensland		10	0		10	0
Mount Lyell, Tasmania		12	6	1	0	0
Mount Morgan, Queensland		11	3		11	6
Namaqua (£2), Cape Province		17	6	1	10	0
Rio Tinto (£5), Spain	27	0	0	27	0	0
Russo-Asiatic Consd., Russia		6	3		9	6
Sissert, Russia		5	0		4	0
Spassky, Russia		7	6		12	6
Tanganyika, Congo and Rhodesia		18	9		16	6

LEAD-ZINC:

	Nov. 7, 1921 £	s.	d.	Nov. 6, 1922 £	s.	d.
BROKEN HILL:						
Amalgamated Zinc		16	3	1	0	0
British Broken Hill		18	9	1	8	9
Broken Hill Proprietary	1	10	0	1	7	6
Broken Hill Block 10 (£10)		10	0		6	3
Broken Hill North	1	10	0	2	2	6
Broken Hill South	1	6	3	2	3	9
Electrolytic Zinc Pref.		—		1	6	3
Sulphide Corporation (15s.)		10	0		13	9
Zinc Corporation (10s.)		9	0		12	6
ASIA:						
Burma Corporation (10 rupees)		6	3		6	9
RHODESIA:						
Rhodesia Broken Hill (5s.)		5	0		6	6

TIN:

	Nov. 7, 1921 £	s.	d.	Nov. 6, 1922 £	s.	d.
Aramayo Mines, Bolivia	1	15	0	2	17	6
Bisichi (10s.), Nigeria		4	0		6	9
Briseis, Tasmania		2	6		4	6
Chenderiang, Malay		11	3		5	0
Dolcoath, Cornwall			9			6
East Pool (5s.), Cornwall		3	0		3	3
Ex-Lands Nigeria (2s.), Nigeria		1	3		2	3
Geevor (10s.), Cornwall		2	9		6	0
Gopeng, Malay	1	12	6	1	18	9
Ipoh Dredging, Malay		10	0		11	3
Kamunting, Malay	1	0	0	1	1	3
Kinta, Malay	1	12	6	1	12	6
Lahat, Malay		10	0		8	9
Malayan Tin Dredging, Malay		17	6	1	10	0
Mongu (10s.), Nigeria		8	9		13	3
Naraguta, Nigeria		12	6		15	0
N. N. Bauchi, Nigeria (10s.)		1	6		2	6
Pahang Consolidated (5s.), Malay		5	0		7	0
Rayfield, Nigeria		1	6		3	3
Renong Dredging, Siam		17	6	1	5	0
Ropp (4s.), Nigeria		4	6		7	6
Siamese Tin, Siam	1	15	0	2	7	6
South Crofty, (5s.) Cornwall		3	6		6	3
Tehidy Minerals, Cornwall		5	0		8	9
Tekka, Malay		15	0		17	6
Tekka-Taiping, Malay	1	1	3	1	0	0
Tronoh, Malay	1	1	3	1	12	6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

LEACHING REDUCED COPPER ORES WITH AMMONIA

British Patent 185,242, published last month, contains a description of a process for treating carbonate, silicate, and other non-sulphide ores of copper, by first reducing the copper to the metallic state by the action of producer gas or coal gas and then dissolving out the copper by means of ammonia. The patentees are Walter G. Perkins, T. J. Taplin, H. L. Sulman, and Hugh F. K. Picard. The patent is controlled by Minerals Separation, Ltd., and the process is to be applied at Bwana M'Kubwa, Northern Rhodesia. We quote the specification at some length.

This invention consists in improvements in the treatment of ores containing oxidized copper compounds, for the removal of the contained metal therefrom by hydrometallurgical methods. There are several oxidized copper compounds which commonly occur in ores which are to be treated by the process; of these, one of the most important is silicate of copper, such as chrysocolla, $CuO.SiO_2.2H_2O$; another class includes copper carbonate or hydrated basic carbonate of copper such as malachite and azurite; certain ores contain oxychloride of copper such as atacamite $CuCl_2 3Cu(OH)_2$. Many copper ores suitable for treatment according to this invention contain two or more of such oxidized copper compounds. The process constituting the invention described comprises heating the crushed ore in a reducing gas for such a short time and at such a low temperature as to reduce the copper compound without melting or alloying the copper and without fritting the gangue so that the reduced material is in a porous condition, and thereafter submitting the product to a leaching operation with an ammoniacal solvent of copper in the presence of air or oxygen.

The inventors have found that when an ore containing one or more of these oxidized copper compounds, in a suitably crushed state, is heated in a reducing gas at a comparatively low temperature (say between 150° C. and 400° C.) for a short time (say 15 minutes to 1 hour), the copper in combined form is reduced to a state in which it can be readily extracted by a known ammoniacal solvent of copper.

The ore after reduction is cooled, but it is not necessary to cool in reducing gas because it is not essential to prevent the formation of films of oxide on the reduced copper. The cooled ore is submitted to a solvent consisting of a solution of ammonia containing some ammonium carbonate. A suitable ratio is 0·8 part CO_2 to one part of NH_3. The solution is effected in the presence of air or oxygen. The copper is recovered from the ammoniacal solution by distilling off the ammonia. If evaporation be slow copper carbonate is precipitated, but by using steam or boiling rapidly, black copper oxide is precipitated. The ammonia volatilized is passed into a condenser and the aqueous condensate is used for the next dissolving operation.

The invention is particularly applicable to the treatment of ores containing copper silicate (such as chrysocolla), the treatment of which has hitherto presented many difficulties. The ores are often too poor to be smelted economically, and in any event tend to produce slags very high in copper with but poor metal recoveries. Hydrometallurgical methods suffer from the disadvantage of the relative insolubility of the silicates of copper in most of the available solvents; or if the silicates be attacked by such solvents, they tend to produce finely divided or gelatinous silica which hinders filtration and often precludes complete attack of the mineral by the solvent.

The inventors have found that when copper silicate is heated in a suitable reducing gas such as hydrogen, producer gas, coal gas, etc., to a comparatively low temperature, usually less than 400° C. and even below 200° C., the copper combined as chrysocolla is reduced. The so-treated particles are now of dark colour and have become porous and readily permeable to liquids; a particle adheres to the tongue, and a drop of water when placed on it is absorbed instantly. The reduction takes place very rapidly and is usually complete in about 15 to 20 minutes for particles below one-twentieth of an inch in diameter. As the heating of the material is continued the solubility of the copper diminishes. Investigation has also shown that advantage may be taken of the finely-divided state of the reduced material and of the now porous nature of the treated particles to recover the metal by solution. The reduction temperature must be such as will not melt the reduced copper, not permit it to alloy with other metals which may be present, nor should such temperature be high enough to frit the ore-gangue, and thus imprison the reduced copper, or surround it in such manner as will render it less accessible to the solvent liquor.

The inventors have also found that it is advantageous to apply the same process of preliminary reduction to certain other oxidized copper ores, such as copper carbonate ores. If an ore containing hydrated carbonate of copper, such as malachite and azurite (crushed, say to 60 mesh) be reduced at a temperature of about 300° C., for about 15 minutes, the copper contents are readily soluble in an ammoniacal liquor containing ammonia and ammonium carbonate in the presence of air or oxygen. Again, if the crushed ore containing copper carbonate be reduced at a temperature of 400° C. to 500° C. (or higher), the copper contents are found to be in a form which is less readily soluble than the material reduced at 300° C., and again as the heating of the material is continued the solubility of the copper diminishes.

In all cases the inventors have found that, in order that the reduced copper material shall be readily soluble in the ammoniacal liquor, it is important that the temperature during reduction

should be kept to the minimum which is consistent with effective reduction. The temperature preferred for the reduction is in the neighbourhood of 300° to 400° C.

In carrying out the solvent operation with ammonia or ammonium carbonate the necessary atmospheric oxygen may be supplied by the suitable exposure of the solvent liquor to air or by similar exposure of the pulp to air; the operation may be hastened if desired by entraining a current of air bubbles in the pulp of reduced ore and solvent, as, for example, by employing leaching apparatus of the Pachuca type; where a current of air is employed the apparatus should be connected with a trap to intercept and recover any ammonia which may be volatilized in the air current.

While any carbonate of copper minerals accompanying the copper silicate minerals are similarly reduced to the metallic state, and the copper is recoverable by ammonia, any sulphides of copper present in the ore will remain substantially unaffected either by the reduction operation or by the ammoniacal solvent; if present such sulphides may be recovered by concentration, flotation, or magnetic means, from the leached residue resulting from the treatment above described.

The method is further applicable to oxidized copper ores containing earthy carbonates or other strongly basic materials in the gangue, since these or other oxides do not destroy or inhibit the action of the ammoniacal solvent as they would destroy or interfere with acid solvents or with such solvents as solutions of ferric sulphate, ferric chloride, etc.

The recovery of copper from the ammoniacal solvent as high-grade oxide is effected by the simple procedure of expelling the ammonia by heat; as the elimination of the ammonia proceeds the copper oxide separates as a granular product, while the ammonia or ammonium carbonate is condensed and recovered for re-use. Since the copper oxide is practically pure it is readily converted into high-grade copper by direct reduction.

An example of the invention may be cited in the treatment of an oxidized copper ore containing 6·49% of copper. Of this amount 0·75% was present as malachite, $CuCO_3.Cu(HO)_2$, and about 0·2% as sulphide, the balance of the copper mineral being chrysocolla, $CuO.SiO_2(H_2O)$; the gangue was mainly siliceous, but also carried the substantial amount of 34% of calcium carbonate. The material is representative of a class of copper ores which has hitherto proved economically intractable. A sample of 100 grammes of ore crushed to pass 30 mesh was submitted to reduction in a rotary cylinder externally heated, through which a current of reducing gas (town-gas) was passed; water commenced to be eliminated at a temperature below 150° C. and reduction of the CuO then became rapid, being mainly effected in about 15 minutes, by which time the temperature had reached 385° C. When the temperature reached 410° C. the operation was stopped and the charge allowed to cool. The cooled ore was now submitted to a leaching operation, using a sufficiency of a solution of ammonia and ammonium carbonate (containing about 7% total NH_3) to yield a mobile pulp, this was placed in a cylindrical vessel of the Pachuca type, that is, fitted with a central vertical tube immersed in the pulp through the lower end of which air bubbles were passed; this introduced the necessary oxygen supply and served to keep the pulp in circulation; an ammonia trap was supplied to recover any ammonia carried off by the air current. After 6 hours the solution was drawn off, and the residual sands washed free from dissolved copper. The solution was boiled till free from ammonia and the resulting deposit of granular copper oxide was found to carry 5·218 grammes of copper. This is equivalent to an extraction of 80·4% of total copper in the ore, in the shape of a product reducible to pure metallic copper by the simplest possible form of smelting.

Another example may be given. A South African ore containing 9·45% Cu as a mixture of malachite and chrysocolla in a silicate gangue was reduced at a temperature of 300° C. in a current of coal gas. The resulting product (which now assayed 9·8% Cu) was mixed with a solution of ammonia and ammonium carbonate and agitated in an apparatus similar to that used in the last test. A total agitation period of two hours was allowed when the charge was filtered and the exhausted residues washed free from soluble copper. This residual material showed an assay-value of 0·49% Cu, which is equivalent to an extraction of 95·5% of Cu in the ore.

In the following example of the application of this invention the test was carried out on a larger scale. 100 lb. of copper oxide ore from the Kambove mine, Katanga, containing malachite, chrysocolla, and other copper minerals, was dried and pre-heated at from 300 to 380° C. It was then reduced in an atmosphere of coal gas at a temperature ranging from 280 to 340° C., the gas being pre-heated. The reduced material contained 15·05% of copper, and after being leached with a solution of cupric ammonium carbonate for 77 hours, the copper extraction equalled 97·8%, the tailings assaying 0·39% of copper.

In treating ores containing oxychloride of copper such as atacamite $CuCl_2 3Cu(OH)_2$ the inventors find that the copper during the reduction process is reduced partly to metallic copper and partly to cuprous chloride Cu_2Cl_2, some hydrochloric acid being evolved. In this operation care has to be taken to avoid heating too strongly so as to volatilize cuprous chloride. In a practical test atacamite was heated to 300° C. in town coal-gas, and of the total copper present in the mineral 97·5% remained behind in the furnace in the shape of a reddish powder. The remainder of the copper was in the form of a small sublimate, but any volatilized chloride can be caught in water and easily recovered. The copper in the treated ore is readily soluble in ammoniacal solvent. The copper chloride is dissolved as ammonium copper chloride. When the solution is boiled for the recovery of ammonia as above described, only the copper present as ammonium copper carbonate or ammonium cuprate comes down direct as copper oxide. The copper present as chloride remains dissolved. If the equivalent of a caustic or carbonated alkali be added either before boiling off the ammonia or after, the copper is thrown down as oxide. Caustic lime may be used, but no excess of lime must be used because it would come down with the copper.

The process may be modified to include reoxidation of the metallic copper (after reduction) prior to the leaching operation. The oxygen necessary for the dissolution of the copper by the solvent is here already contained in the copper product to be leached; the ore although re-oxidized is

not re-hydrated, nor must the re-formed copper oxide be permitted to recombine with silica. This will not take place if the re-oxidation of the copper be effected at a moderate temperature.

Heretofore it has been found that in treating raw oxidized ores or raw ores containing native copper, by an ammonia solvent for the extraction of the copper, some ammonia tends to be adsorbed by and lost in the extracted ore-slimes; but according to this invention the disadvantage of such ammonia loss is greatly minimized by the interposition of the reduction operation. Thus the residual slimes resulting from the ammonia extraction of a reduced ore as hereinbefore described, was found to carry only 0·7 lb. of NH_3 per ton of slime material.

SILVER-LEAD IN THE TRANSVAAL

The *Journal* of the South African Institution of Engineers for September contains a paper by H. W. Clayden describing the concentration and smelting operations at the mines of the Transvaal Silver and Base Metals, Ltd. As readers are aware, these old properties were reopened by the Albu group in 1919, and smelting began this year.

The property is situated on a base-mineral belt which crosses the Apex-Witbank line near Argent Station, continuing in a north-westerly direction towards Pretoria. The company has options and mining rights over a large area of country situated on this belt, and is at the present time operating mines opened up on the farms Dwarsfontein and Brakfontein. The present No. 1 mine is one of the original shafts worked by the old Transvaal Silver Mines in the early nineties. The chief difficulties of the old company were the transport of all stores, materials, and concentrates from and to Charlestown, in Natal, which was at that time the nearest railhead, and the transport of all coal from the Witbank district. The cost of this transport and low metal prices led to mining operations proving unpayable, and the mine was closed down in the year 1895. In December, 1919, the present company was founded under the control of the General Mining and Finance Corporation, and operations to open up the property were commenced in March, 1920. With the Apex-Witbank railway within 1½ miles of the present reduction plant, the early difficulties of transport over 150 miles have disappeared.

In March, 1920, the sinking of one new shaft was commenced, and a start was made to reclaim the old Silver Mines shaft. This shaft had caved in, and consisted of a hole in the ground about 40 to 50 ft. in diameter by 20 ft. deep, the water level in the old workings being about 25 ft. from surface. The reclamation was carried out by installing a pump in one of the old surface winzes, and after stepping back the ground round the caved shaft the re-excavation of the shaft was commenced, the water being lowered as the caved ground was removed. The top of the old shaft timbering was recovered at 40 ft. from the surface. The timbering was then renewed to surface, and a steel collar sett installed, the main joists of which were supported on 15 ft. concrete piers built on solid ground about 15 ft. from the side of the shaft. On this collar sett the headgear and shaft timbering are carried. When this collar sett was completed a start was made to reclaim the workings, the old shaft being over 300 ft. deep. An air lift, consisting of a 6 in. pipe line lowered to the shaft bottom, with a 2 in. air pipe lowered into it, was used to unwater. By this means 750,000 gallons of water per 24 hours were pumped, and within 14 days the water in the workings and surrounding country was drained off to the 200 ft. level, at which point steam pumps were installed. Since that date a main electric pump station has been cut and equipped in this shaft.

The original plant at each of these shafts consisted of a small hoisting engine, 40 ft. headgear, a small compressor, and loco boilers. The No. 1 shaft equipment has since been increased by installing a 13 in. by 26 in. geared Robey hoist and boiler plant, the headgear being raised to 60 ft. and ore bins erected. Early in 1921 a third shaft was opened at Brakfontein, about three miles from the No. 1 shaft. In opening these old workings the same air lift scheme was adopted, but over thirty million gallons of water had to be pumped before the surrounding country was drained off to give a normal make in these workings of about five million gallons per month. Another old working is at present being unwatered on the farm Oudezwaans Kraal.

In January, 1921, the company decided to erect a dressing plant and smelter capable of producing 500 tons of silver-lead bullion per month, and by this means bring the mine to a producing stage on such a scale as to make it self-supporting in the future. The position of the plant was fixed near No. 1 shaft. Ore from Nos. 2 and 3 shafts is at present transported by ox-wagon to the crusher station.

The crusher and sorting station is of the ordinary Witwatersrand type, with receiving bin, primary jaw crusher (crushing to 5 in. cube); by belt conveyor to trommel and washing plant; then over sorting belt to two secondary crushers, and on by belt conveyor to the mill storage bin of the concentration plant. All fines screened by the headgear grizzlies are also trucked to this conveyor belt for delivery to the mill bin. The sorting floor is carried over the waste bin, but after the waste has been sorted a separate bin is provided, in which all high-value hand-picked ore is placed. This ore can be sent direct to the roasting plant without concentration. The two secondary crushers are of the Sturtevant roll jaw type, size 20 in. by 6 in. Each crusher, when breaking to ¾ in. mesh, is capable of dealing with from 10 to 12 tons of ore per hour. All ore, except screened fines—minus ¾ in. mesh—is passed through them after sorting and hand picking.

From the crushing mill bin the ore is delivered by bucket elevator to the first floor of the concentration building into a ¼ in. mesh, sizing and washing trommel. The oversize from this trommel is delivered to a set of 16 in. by 36 in. Allis-Chalmers rolls. After passing the rolls, which crush to ¼ in., the product returns to the boot of the elevator, thus making a closed circuit, the only ore leaving which is that screened through the wash trommel as minus ¼ in. product. This ¼ in. product falls to the boot of No. 2 elevator, delivering to the second floor of the building, where, after sampling for assay value, it is passed through two sizing

trommels with $\frac{1}{8}$ in. mesh screen. These are the first sizing trommels for six two-compartment Harz jigs, each with a screen area of 11 sq. ft., which are placed on the jig floor. The plus $\frac{1}{8}$ in. product from the trommels passes to Nos. 1 and 2 jigs, the undersize with the pulp passing to a hydraulic classifier, which sizes the product for the Nos. 3 and 4 and Nos. 5 and 6 jigs. The fine pulp overflow passes to the ball-mill head cone. There is no reject tails from the jigs, as the mineral in the ore is very finely disseminated ; the whole overflow from the jigs is therefore passed to the ball-mill cones. The concentrate, either from the jig screen or hutches, is collected in conical bins, and after discharge is trucked to the roasting plant.

The overflow of the ball-mill cones is run direct to a 40 ft. Dorr thickening tank, and the water, after settlement, is returned to a steady-head tank, situated above the concentrate plant. The underflow of the cones is taken to two Dorr classifiers in closed circuit with two Hardinge 6 ft. by 22 in. conical ball-mills, 2 in. diameter steel balls being used in these as the grinding medium. Each of the mills is capable of grinding 100 tons per day, the average grading at present being :— Classifier intake, 60% plus 0·1 in. ; 32% plus 0·01 in. ; 8% minus 0·01 in. Classifier outlet, 12% plus 0·006 in. ; 29% plus 0·003 in. ; 59% minus 0·003 in. The classifiers were originally erected with a grade of 2 in. to the foot, but, owing to the pulp gravity, this has now been increased to 3 in. to the foot, and a worm conveyor is installed to deliver the classifier product to the ball-mill feeder. The consumption of steel balls in these mills, each grinding 100 tons per day on the above grading of pulp, is about 1·5 lb. per ton ground. To the ball-mill circuit is added the tar required for the flotation process, this being done in order to get it intimately mixed with the finer particles of mineral in the ground ore. The tar at present used is obtained from the Johannesburg Municipal Gas Works.

The Dorr classifier overflow is delivered on to fine screening to remove as far as possible any wood pulp or coarse chips which tend to choke the flotation machine, and after passing this screen is delivered to sand pumps for elevation to a main cone in the flotation house, the overflow of this cone passing to the Dorr thickener. In the flotation house the underflow of this cone is laundered to the head of a 10-compartment Minerals Separation sub-aeration type machine, and to the same launder is added the fine slime from the Dorr thickener, which is raised by a 4 in. diaphragm pump ; also the remaining flotation reagent, consisting of cresol with a water ratio of, roughly, 3 to 1.

The type of flotation machine in use consists of a series of ten compartments, each about 18 in. square, built up in the form of a box launder, 25 ft. long by 2 ft. wide by 3 ft. deep from the discharge lip. In each compartment a propeller revolves, driven from an overhead shaft by bevel gearing at a peripheral speed of about 1,000 ft. per minute. Air is supplied by a small blower of 100 cu. ft. capacity at about 2 lb. pressure per sq. in., and is admitted to each compartment below the centre of the propeller, and the compartments are covered with wooden grids about 15 in. below the pulp level. The air, broken into small bubbles by the propeller, rises through the pulp and floats over the lip of the machine as a froth, carrying any mineral particles which are attached to the air bubbles by surface tension. The first compartment of the machine is used for agitation only ; from the next five compartments a high-grade finished concentrate is obtained ; on the last four compartments of the machine a low-grade concentrate is obtained, this being returned to the head of the machine for re-agitation and re-treatment. The high-grade concentrate is pumped to settlement cones, and from these trucked to pits for sun drying. The tailings from the machine are pumped to sand and slime dams. The whole of this plant is electrically driven, requiring 230 k.v.a., equipped with a 75-h.p. motor for each ball-mill, a 50-h.p. motor for the flotation machine, with smaller independent drives on the various pumps, elevators, and jigs. The plant was started up in January, 1922.

The jig concentrate, containing about 60% of the total ore value at the head of the plant, is a clean smelting product containing an average of 60% lead and 10% sulphur. The Minerals Separation concentrates are not quite so high in lead, and the sulphur contents is in the neighbourhood of 15%. The whole of this product is trucked to the desulphurizing plant, also any hand-picked galena from the crusher station.

The desulphurizing plant in which the concentrates are next treated consists of three Huntington-Heberlein pots of 9 ft. diameter by 4 ft. deep, each 160 cu. ft. capacity, holding about 12 tons of charge. The pots are mounted upon a carriage for tramming to the breaking floor, and carried on a pivot, so that the contents, when desulphurized and sintered, can be discharged on the floor. All concentrates passing $\frac{1}{4}$ in. mesh are bedded on a mixing floor with granulated slag, ironstone, and limestone, all crushed to $\frac{1}{4}$ in. mesh, and after a thorough mixing delivered by a conveyor belt to the bin in the pot-house. The pot-house and blast-furnaces are supplied with air for blast purposes by three Roots blowers, each capable of delivering 3,000 cu. ft. of free air per minute against 2 lb. pressure per square inch. These blowers are housed in a separate building, situated between the pot-house and furnace plant.

The method of operating the desulphurizing pots is as follows :—A coal fire is lighted on top of the wind-box grate, and air is supplied from the blower mains. A layer of mixed charge is then placed over the hot coals, and the sulphur in the ore starts to burn. After a 4 in. layer of the charge is well lighted, the pot is filled with mixed concentrate charge from the bin, and the air blast is turned on full with about 8 oz. air pressure. After a 10-hour roast the majority of the sulphur contents is burned off, being reduced to about 3 to 4%, and the heat given off by the same has sintered the mass into one solid cake. This cake sinter is then tipped from the pot on to a breaking floor, and is broken up into 4 in. to 6 in. cubes for smelting in the furnaces. The sulphur fumes from the pot plant are collected by hoods placed over the pots, and are discharged into the main flue, which is 250 ft. long, 6 ft. by 6 ft. inside diameter, with a 7 ft. diameter by 100 ft. steel chimney. Into this same flue the blast-furnace gases are discharged after passing through a dust-settling chamber.

In the blast-furnace house two furnaces are installed, one a small circular furnace of 36 in. diameter, which was imported, and the second a rectangular blast-furnace 6 ft. by 3 ft. at the

tuyeres, which was completely built in Johannesburg. Both furnaces are of the water-jacketed type, with a 20 ft. charge stack between the crucible and the charge floor. The furnaces are charged from the charge floor, at the back of which, carried on concrete piers, are situated the ore and flux bins, containing sintered and oxidized ore, ironstone, limestone, and the necessary coke. All the charge is elevated to these bins by means of an electric hoist, which winds trucks up an inclined plane. Each furnace charge at quarter-hourly intervals is weighed on the charge floor and is fed into the stack of the furnace. The blast required for smelting is from 3,000 to 5,000 cu. ft. of air per minute at about 20 oz. pressure. The lead is run off from the lead well in the crucible by means of a syphon built in the crucible. The slag and matte is tapped at the end of the furnace, and after parting the slag is placed on the dump and the matte containing any copper in the ore is re-crushed and again passed through the roasting process, to eliminate the sulphur. The silver-lead bullion from the lead well is run into 110 lb. pigs, and in this state is shipped to Europe for softening and desilverizing. The amount of silver obtained from the pig at present smelted is about 100 oz. to the ton of lead.

In the future should a demand for silver and soft lead arise locally the lay-out of the plant allows for a desilverizing and softening plant, which would be built in a house to the north of the smelting plant.

IRON-ORE RESOURCES OF THE BRITISH EMPIRE

We continue herewith the publication of extracts from the reports on the iron-ore resources of the British Empire issued by the Imperial Mineral Resources Bureau. Previous references to these reports have appeared in the September and October issues.

India.—It is not necessary to quote the report on Indian deposits as these were dealt with by Dr. J. Coggin Brown in the MAGAZINE for June and July, 1921, and by Ernest Parsons in the issue of January last. We merely give herewith the summary of available resources.

In his notes on the Iron Ores of India, written for the "Iron Ore Resources of the World" (Stockholm, 1910), Sir Thomas H. Holland pointed out that no estimate of the total iron-ore resources of India had ever been made. The two groups of rich hematite ore-bodies, one in the northern part of the Mayurbhanj State of Orissa and the other in the Raipur district of the Central Provinces, had been investigated more carefully than any other occurrences and definitely proved to contain 100 million tons with a strong probability of 500 million tons of ore. Sir Thomas Holland also gave a much-needed warning that such descriptions as "inexhaustible" and "enormous" which often occur in old reports on the Dharwarian quartz-iron-ore-schists found in many parts of India, and applied to their reserves, were not to be taken too literally, and were due to the fact that the deposits were then out of all proportion in excess of any probable local consumption. While the total resources were certainly very large, the proved instances of their concentration into workable ore-bodies are comparatively few, and it is to them that later work has been more or less confined, though with results, as will presently be shown, which remove all anxiety as to India's supplies of high-grade ores for her rapidly expanding iron and steel industry. In 1910 the Bengal Iron and Steel Company was still using the clay-ironstone nodules of the shales separating the two main coal-bearing horizons of the Lower Gondwana system in the Raniganj coalfield, supplementing these supplies by magnetite from Kalimati. In fact it was not until 1910 that this company's mines at Manharpur in the Kolhan Estate of Singhbhum were opened up. The Tata Iron and Steel Co., Ltd., had already secured mining leases over the Gurumaishini, Okampad, and Badampahar deposits of Mayurbhanj.

It may be stated that there is no further information available regarding the reserves of clay-ironstone or of the ferruginous laterites. The only known abundant source of the former has been largely worked and may be approaching exhaustion, while the superficial deposits of the latter are usually very lean ores and cannot be regarded as important reserves.

It is as true to-day as when Sir Thomas Holland wrote in 1910 that no estimate of the total iron-ore resources of India had ever been made. The additional data available are mainly those made public by the geologists and engineers of the iron-ore mining companies regarding the deposits examined by themselves.

The most striking discovery since 1910 is that of the iron-ore ranges of southern Singhbhum and of the Bonai and Keonjhar States of Orissa, where hematite deposits have been traced for a distance of 30 miles; the minimum quantity of high-grade ore (60% iron and over) is about 3,000 million tons according to estimates made by H. C. Jones, of the Geological Survey of India.

In Mayurbhanj the Gurumaishini deposit was originally estimated to contain 7·5 million tons of ore running from 60 to 63% of metallic iron and 0·10% of phosphorus. This deposit and others which occur in the same State are now estimated to contain 39,400,000 tons of non-titaniferous ores of 60 to 67% of metallic iron. This estimate has been published recently by C. P. Perin, consulting engineer of the Tata Iron and Steel Co., Ltd. The same writer, dealing with the iron-ore reserves of the Central Provinces, recalls how 2·5 million tons of ore have been proved to exist in the Rajhara deposit, how an adjoining one is now assumed to contain 7½ million tons, the average composition of the whole being 67 to 68% of iron with 0·6 to 0·9% of phosphorus; and states that this particular iron-bearing area is now known to have a considerable extension to the south and to carry a tonnage variously estimated from 20 to 30 times that actually proved. Mr. Perin concludes as follows:—"Since the beginning of the war, prospecting parties have been continuously in the field working in a quadrangle 400 miles east by west by 200 miles north and south, beginning at Calcutta as the north-east corner. After investigations by some 20 prospectors, engineers of experience and geologists connected with the different companies who have made these investigations, there is now estimated to be about 20,000 million tons of high-grade ore within a maximum distance of the fuel of 500 miles, and an average distance of 120 to 130 miles." This estimate

presumably includes both the Dharwarian ores of the Bihar and Orissa and of the Central Provinces. It does not include those of Mysore or the various other districts.

It will be seen from the foregoing that India possesses sufficient high-grade iron ores to supply an iron and steel industry of the first magnitude, and the rapid developments which are taking place show that this fact is fully appreciated by capitalists. The day would not seem to be far distant when India will be self-supporting as regards iron and steel, and will probably be exporting pig iron, which, in the opinion of those best able to judge, can be produced comparatively cheaply owing to the low assembly-costs consequent on the close proximity of raw materials and the cheap rates of freight.

Ceylon.—Iron ores are fairly widely distributed in Ceylon, but they do not appear to be of commercial importance at the present time. They occur in the form of (1) magnetite, (2) limonite and hematite, and (3) ilmenite. Magnetite occurs as a common accessory mineral in pegmatite, frequently accumulating on the surface through weathering of the parent rock, but the available quantity of the mineral appears to be very small. The limonite and hematite deposits are found: (*a*) in bands following the outcrop of rocks rich in iron minerals, especially garnet-rocks, and resulting from the decomposition of the latter, and (*b*) as irregular masses of lateritic ironstone called "kabuk," resulting from the decay of rock in situations where denudation acts slowly. Ilmenite is found in the form of sand in two large beach deposits on the east coast of the island: (*a*) at Pulmoddai, 30 miles north of Trincomalee, and (*b*) at Tirukkovil, 30 miles south of Batticaloa. It is also found in smaller quantity at many points on both coasts. The "kabuk" deposits are purely superficial, as they are limited to the zone of extreme chemical alterations of the rock-forming iron minerals, which is at most only a few yards in depth. Although their distribution is wide, and the aggregate quantity probably large, the deposits are of little commercial importance. The largest deposit of iron ore in Ceylon is on the Kiribatgala estate, and has been estimated to contain only 50,000 tons. The ore here is favourably situated for exploitation, as it all lies close to several roads and could be easily loaded into carts. The Pelmadulla railway passes within a mile of the deposits. A sample from this deposit, sent to the Imperial Institute in 1912, consisted of brown hydrated iron ore, which upon analysis gave 54·6% iron and 1·56 P_2O_5.

Farther north iron ore has been noted at Ampitiya and Hanguranketa, and numerous points in the area around Nuwara Eliya, Badulla and Bandarawela. In all cases the ore is a surface deposit due to the decomposition of the older rocks. These ores were formerly used by the natives who manufactured iron implements on the island, but they are too irregular in distribution and inconsiderable in amount to be of any use for export, and in the absence of local coal the ore could not be smelted locally with profit.

British Malaya.—Extensive ferruginous deposits, known locally as laterites, occur throughout the Straits Settlements and Federated Malay States. They consist of dark-red or nearly black iron oxides sometimes associated with shale and sandstone. In structure they may be either compact or cellular, resembling a scoriaceous basalt, and they frequently occur in the soil or in weathered shale or sandstone. They are found in Taiping and many other places, where they are extensively quarried for road metal. A long range of granite mountains stretches from the north-east to south-east in the Peninsula. Subsidiary granite ranges occur towards the west; and on the east, in the centre of Pahang, there is the huge isolated Benom Range composed entirely of granite. In Pahang there are also conglomerate and sandstone outcrops forming a long line of foothills, while at Kiala, the chief mining district of Perak, limestone occurs. At Pondok Tanjong and on the road to Selama in Larut the deposits form more or less regular seams which dip at a high angle. Their origin is attributed to deposition by solutions of carbonate of iron, though in some cases they may be due to alteration *in situ*. In the State of Trengganu there is a rich deposit of magnetite in the vicinity of Dungun on the China Sea coast. It covers an area of about 2,000 acres between the Dungun and Paka Rivers. The Kuhara Company, a Japanese enterprise, has leased about 1,000 acres. In the State of Pahang titaniferous iron ore occurs near the sea-shore around Kuala Kuantan. In the State of Johore, a large vein of iron ore about 2,640 ft. in length and 60 ft. broad has been found. The outcrop at its highest point is said to be 300 ft. above river level. The deposit consists of hematite with some magnetite, and in bulk is stated by the Japanese exporting company to contain 50 to 60% iron. The impurities include quartz and calcite. This deposit is situated 25 miles up the Sempang Kiri River from Kuala Batu Pahat. Production commenced in January, 1921. The company expects to produce 6,000 tons a month, and before long to reach a monthly output of 10,000 tons. The ore is loaded from lighters into a steamer at Kuala Pahat for shipment direct to Japan, where the value of the ore is stated to be £1 10s. 4d. per long ton. In the southern part of the State of Kedah, concretionary masses occur in the soil. These are believed to consist of hematite and limonite, but on Kedah Peak veins of magnetite appear in the quartzite. On the north-west flank of this peak, above the coast-village of Yen, there is a magnetite vein that looks promising, but its extent has not as yet been proved. If the deposit should prove large enough to be worked, the ore could be taken by aerial railway to the vicinity of Yen.

Borneo.—Important deposits of limonite are found in British North Borneo, at Tagoho Hill, thirty-five miles south of the manganese deposit at Taritipan in the north of the State. The amount of metallic iron is not expected to exceed 56%. The quantity available is stated to be at least 25 million tons. Coal is also found in this territory in Elphinstone province in the extreme south of the State, and at Batu Batu on the shores of Brunei Bay and elsewhere. Concretions of clay ironstone occur in the coal-bearing strata of Labuan and other localities. Iron ores are widely distributed in Sarawak. They consist partly of magnetite and partly of argillaceous slaggy ironstone. They are met with in the alluvial deposits and are stated to be in the nature of lateritic decomposed products. The richest ore reported occurs in the district of Ridjang, where it is stated to contain from 60 to 80% of iron oxide. In Brunei, iron ores occur in the basin of the River

Barram. In Sabah they are widely distributed in the Tertiary beds occurring near Kudat in the Bay of Marudá, also on most of the hills near the River Labuk between Tunder Batu and Punguh and near Pinunruh on the River Kinabatangan in the coal districts. Iron sands, consisting of a mixture of chrome iron-ore and magnetite, are stated to occur in the alluvial deposits.

Hong Kong.—Hong Kong island has an area of 32 square miles. The territory attached to this colony, held on a 99 years lease as from 1898, consists of a strip of country on the mainland of China behind Kowloon, and numerous adjacent islands, and covers in all an area of 376 square miles. The mainland portion of the territory is largely occupied by granite and highly metamorphosed sediments. The iron ore occurs as contact deposits and as superficial masses. The Ma-On-Shan deposit lies about a mile south-west of the Ma-On-Shan peak, the distance from Tide Cove being about 1½ miles, and from the navigable waters of Tolo harbour about 2½ miles. The ore-body is first seen about ½ mile south-east of Ma-On-Shan village, and extends for some 2,000 ft. in an easterly direction ; its western extremity lies about 800 ft. above sea-level, and its eastern extremity about 1,200 ft. The highest point of the peak is 2,260 ft. above sea-level. The ore-bed dips towards the north at from 30 to 60° from the horizontal. At most points where the contact is observable the ore lies directly upon granite, but in places a considerable area of quartzite intervenes. At one point small veinlets of molybdenite were found in the quartzite. The ore-body attains a thickness of about 100 ft., and consists of two members, namely, pure magnetite and greenstone, which closely resembles the "skarn" of the iron-ore belt of central Sweden. The relations between the two are highly irregular, and as a rule the magnetite occurs abundantly disseminated throughout the skarn in bodies ranging from isolated minute crystals to pure masses comprising thousands of tons. In its pure, massive form the magnetite is generally rather soft and granular. There are no well-defined boundaries between the magnetite and the greenstone, the one grading imperceptibly into the other. Other occurrences of iron ore lie to the north-west of Tide Cove, near the coast of Tolo harbour. The Kowloon-Canton Railway runs through these deposits. Farther to the west, between Kam-Tin and Tsin-Wan, other contact-metamorphic magnetite deposits have been located, while in the same neighbourhood as well as in the north-west and extreme south of Lan-Tau Island veins of magnetic iron ore have been found in the granite. The Ma-On-Shan deposit is estimated to contain at least 5,000,000 tons of high-grade magnetite, which may be classed as "actual" reserve.

Mesopotamia.—The country, as might be expected from its geological structure, is poor in ores. Iron ore is found in the Sergusa Hills, to the north of Amadia, where it was formerly mined. Large quantities of ore are said to be available, but the mine was abandoned owing to insecurity. Other deposits are reported to the east of Amadia, and in the Dohuk district. Iron ore is also found in the valleys of the Bohtan and the Tigris, of which the former river is a tributary.

Palestine.—Iron ore occurs to the east of the River Jordan between the Jabbok and Wadi Radjib Rivers, about two miles south-south-east of Radjib in the Ajlun district. In the main the ore-body is lenticular, occurring as a metasomatic deposit in limestones of Cretaceous age, and consists of red and brown hematite associated with marcasite. The minimum thickness of the deposit is about two feet, and it has been mined to a depth of nearly fifty feet.

Australia and Dependencies.—Particulars have already been given in the MAGAZINE of the iron-ore deposits of Australia. Previous articles deal with iron-ore deposits in West Australia, Tasmania, and New South Wales, March, 1919 ; Yampi Sound deposits, October, 1920 ; Queensland deposits, April, 1921. The Iron Knob deposits in South Australia, worked by the Broken Hill Proprietary, have often been described. For this reason we quote here only the Bureau's general summary.

In New South Wales, the ore produced is mainly used at the Eskdale Iron Works for the manufacture of pig iron and steel, although a small quantity is also used for fluxing purposes. The largest deposits are those situated near Cadia and at Coombing Park near Carcoar.

In Victoria, iron ores are widely distributed and may be divided into three classes, namely, (1) those associated with and derived from Cainozoic basalts, which are usually of low-grade quality and high in titanium ; (2) sedimentary ores associated with the lower Cainozoic continental deposits, and frequently associated with lignite ; and (3) the deposits occurring as specular iron ore in porphyritic rocks. There are considerable reserves, but they do not appear to be of a quality that will allow of their competing with the ores of other Australian States.

In Queensland, iron ore is obtained mainly in the Rockhampton and Cloncurry districts, and is used for fluxing purposes. The Mount Leviathan, Mount Pisa, and Iron Island reserves are the largest known at present, but there are many others the magnitudes of which have not yet been estimated.

In West Australia the principal deposits are situated in an area from Kimberley to Cape Leeuwin, including the rich deposits recently discovered on the islands in Yampi Sound. The ores belong to two classes, namely, (1) those occurring in crystalline schists and (2) surface formations of limonite. The ores of the former and more important class are found chiefly in the Murchison district in connexion with the gold deposits. The deposits consist of dislocated beds, bands, and lenses of almost pure hematite, sometimes mixed with magnetite, in quartz. The extensive deposits occurring on the islands and mainland of Yampi Sound consist of crystalline hematites of micaceous structure, interbedded with quartzites and clay slates. Surface formations are largely distributed throughout the State. Their composition varies very much from ferruginous bauxites or argillites to almost pure limonites or turgites. Besides these, chromiferous laterites and bog iron ores occur in many places. The geographical position and lack of coal militate somewhat seriously against the exploitation of these deposits and have been the cause of their remaining entirely undeveloped. However, the Queensland Government has taken an option of purchase over the deposits on Cockatoo Island, Yampi Sound, with the intention of shipping the ore to the State iron and steel works at Bowen, and blending it with iron ore from Cloncurry.

In South Australia the bulk of the ironstone produced is obtained from the Broken Hill Proprietary Company's property at Iron Knob, and a considerable portion is forwarded to their iron and steel works at Newcastle, New South Wales, for conversion into pig iron and steel. The balance is used for fluxing purposes, the bulk going to the smelting works at Port Pirie.

In Tasmania, iron-ore deposits have been found in a number of places, particularly in the north and north-west portions of the State. The chief deposit is situated at Blythe River, and is in the form of a bed of hematite enclosed in Cambro-Silurian schists and sandstones. In the districts of Beaconsfield and Salisbury also, deposits of brown and red hematite and magnetite occur, these being connected with a massive serpentine intrusive into sandstone and conglomerate.

The greater part of the Northern Territory is unprospected, and, though iron ore has been found at various places, there is no information available upon which to base any estimates as to the quantity or value of the deposits.

Iron ore is known to occur in Papua at several localities, but the only deposit that appears to have been worked is one of hematite in the Mount Louis area.

In New Guinea, iron has been noticed together with copper and platinum near the Kabenau River. The large deposits of phosphates have attracted chief attention, however, up to the present, and there appears to be practically no information upon the iron-ore deposits either in this former German possession, or in the Bismarck Archipelago or Solomon Islands.

New Zealand.—New Zealand contains a number of deposits of iron ore, but so far as is known only two groups of these are large enough and contain ore of sufficiently high grade to be of economic importance at present. These are the deposits at Parapara near the north-west corner of the South Island, and the beds of iron-sand on or near the shore at many localities along the western coast of the North Island. Minor deposits of various kinds are known at many points, such as at the head of the Waitangi River, North Auckland District, at Kerr Point, and elsewhere. The quantities of iron ore available are not easily estimated at present, and further work will have to be done to enable reliable figures to be given. The following quantities are given provisionally as approximating the reserves of New Zealand :—Parapara, 64,000,000 tons ; West Coast North Island, 5,374,000 tons.

The rocks in which the Parapara deposits occur are highly metamorphic. All the large deposits are intimately associated with the ancient complex crystalline carbonates of the Aorere series. By far the most important of the iron-ore bodies occur in the complex carbonate belt stretching irregularly southward from Parapara Inlet along the Onakaka Ridge to and beyond the southern limits of the subdivision. Along this belt there are four distinct deposits. The largest and most northerly is that occurring in the valley of Washbourn Creek, between Parapara Inlet on the north and Tukurua Stream on the south. The second deposit is that situated between the Tukurua Stream on the north and the Onakaka on the south. The third deposit occurs on the Onakaka Ridge between the Onakaka River and the Pariwhakaoho Stream ; and the fourth and smallest deposit appears on the rugged country south of the Pariwhakaoho. In addition to these there are a number of smaller and comparatively unimportant deposits in the old Glen Gyle Sluicing Claim, in Fletcher Creek, and elsewhere. The ore consists almost entirely of limonite, though other hydrated oxides are also present. It is apparently everywhere the result of the oxidation of ferrous carbonate, itself derived from pyrite occurring in great amount in the schists and quartzites associated with marble.

The deposits occurring at many points along the coast of the North Island from Patea northward to Manukau Harbour are of an entirely different character. They consist of iron-sands, occurring in thick beds along the shore and inland for a mile or more, concentrated by the action of the waves and wind. The beds, which are lens-shaped, vary considerably in composition ; some consist almost entirely of iron-sand, though others above or below may contain a large proportion of quartz sands or ferromagnesian mineral. Sand dunes, more or less dark in colour owing to the presence of the iron-sand, and now partly covered by vegetation, extend at intervals along the top of the cliffs from Patea to Kakaramea, and in places reach a quarter of a mile inland. The narrow strip of beach seen at low tide is cumbered with large blocks of sandstone detached from the cliffs. For a mile and a half eastward there is a low coast, fronted by a blacksand beach about 70 yards wide at low tide. Although containing much material of good quality, the iron-sand deposits at and immediately above high-water mark will be difficult and expensive to work owing to the presence of much timber carried down by the Patea River. The sand has been derived in great part from the disintegration of andesites and basalts and fragmental rocks that cover large areas near the coast from Taranaki northward. The iron-ore grains consist of an intimate mixture of magnetite and ilmenite, and experiments have shown that the titanium content is not greatly altered by magnetic or sifting processes. A small proportion of vanadium was contained in all samples examined for this constituent.

LEAD AND ZINC MINING IN THE LAKE DISTRICT

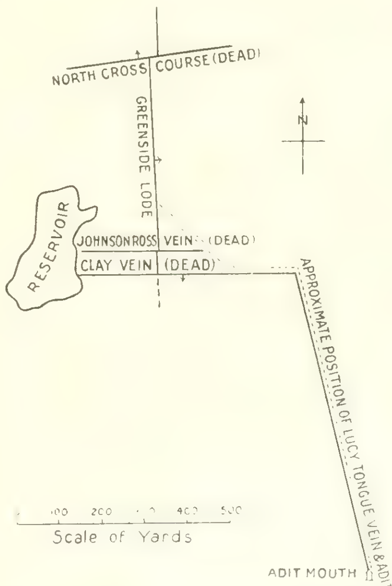
We conclude herewith our précis of Mr. Eastwood's Memoir prepared for the Geological Sutvey on the lead and zinc ores of the English Lake District.

Greenside.—This mine is situated about 1½ miles west of the head of Ullswater, toward Helvellyn. The mine, after a period of intermittent work, has now been in continuous operation for over 100 years. The workings of the latter part of the 18th century are situated on a tableland at 1,850 ft. above O.D., and on Glencoindale Head (2,500 ft. above O.D.). Washing and dressing of the ore was then on a primitive scale and could be carried on only nine months in the year on account of frost and snow. The dressed ore was carried on pack-horse to Keswick or Stonycroft Gill for smelting. The lowest level previous to 1825 was that now known as the high level. Later a cross-cut, from Lucy Tongue Gill, cutting the vein 36 fm. deeper, was made (the " low level "), and from this a shaft was

sunk on the vein. In 1851 the Lucy Tongue level, driven to cut the vein 82 fm. below the low level, was commenced. In 1862 a vertical shaft was made from the Lucy Tongue level with cross-cuts east to the vein. This, after successive deepenings, was abandoned, and in 1891 a new vertical shaft ("Smith's," still in use) was commenced 75 fm. north of the old shaft and $22\frac{1}{2}$ fm. east of the vein which it intersects at about 50 fm. below the Lucy Tongue level. Since then work below the 90 fm. level has been carried on from an inclined shaft on the vein.

The Greenside lode runs approximately north and south for about $\frac{3}{4}$ mile and hades eastward at from 8° to 18° from the vertical, the vein being richer in the steeper portions. Several barren east and west cross-courses displace the lode, the most important being the North cross-course, the Johnson Ross back vein, and the Clay vein. The North cross-course traverses the richest part of the ore-bearing ground about Glencoindale Head, and on its northern side shifts the lode 60 ft. to the east (see accompanying plan). The Johnson Ross and Clay veins, about 50 yd. apart, lie at the south end of the mine. The Clay vein, underlying south, has a good hanging-wall and is composed of soft sandy clay, or flookan. It marks the southern limit of the mine, breaking up the Greenside lode so much that the latter is unrecognizable farther south. The country is composed of lavas, tuffs, and ashes of the Borrowdale Series, and according to W. H. Borlase (see "History and Description of the Greenside Silver-lead Mine, Patterdale" : *Trans. Fed. Inst. Min. Eng.*, vol. vii, 1894, p. 645) ; who has long been connected with the mine, the nature and composition of the vein varies in sympathy with the country rock. The chief ore-bearing sections are in hard massive tuffs. The non-productive parts are in less compact and softer tuffs and ashes, while the vein itself is reduced to small proportions and carries friable quartz with small quantities of iron pyrites. The foot-wall is constant, but the hanging wall is sometimes ill defined, owing to strings of ore penetrating the country. It is usually better defined where the vein is nipped. At the north end of the mine, along the contact with a quartz felsite dyke, the vein is quite dead (see "The Geology of the Northern Part of the English Lake District" : *Mem. Geol. Surv.*, 1876, p. 54).

The vein-filling is mostly a breccia of country rock, the fragments here and there attaining a volume of 2 or 3 cu. ft. Quartz occurs locally, and for short distances may form one-tenth to one-fifth of the vein content. In the higher part of the mine now abandoned, barytes of good colour was locally abundant, but was never worked. When barytes is present the vein generally expands to a great width, yielding in places 10 tons of argentiferous galena per fathom. Calcite is not common, though occasional specimens of "nail-head" spar may be obtained. Galena is the only ore of commercial importance ; there is some blende and a little iron pyrites, but copper pyrites is rarely seen. The galena may be in bunches or small patches, but the best ore occurs in ribs and strings, carrying $9\frac{1}{2}$ to $10\frac{1}{2}$ oz. of silver per ton of pig lead. Where the vein is rich quartz is frequently, but not invariably, associated with the ore. The breadth of the vein is variable. In the upper levels it was, in places, 50 ft. across, but, in depth (where the ore appears to be more concentrated), the average width of the stopes is about 8 ft. At one locality in the 90 fm. level, the vein swells out to 30 ft., while directly beneath, in the 105 fm. level, it splits into three parts. In some of the swells on the 105 fm. level, where the vein is 12 to 15 ft. wide, the hade of the hanging wall is reversed. In the pinched portions (as in places about the 90 fm. level) the vein averages only a foot and is barren. The ore makes its reappearance in the form of sops and small bunches, gradually increasing to stoping quantity and quality. Strings of ore leave the lode at frequent intervals, and are sometimes spoken of as the "feeders from the east." Several of these have been followed, but have proved barren a short distance from the main lode, though they appear to enrich the latter at their junction. Some of the strings appear to be located in definite cross-courses, but in such cases, although easily followed, seldom yield ore. On approaching a cross-fault from the south the ore is usually good up to the slip, but when the vein is located on the north side it is generally of less value.



SKETCH PLAN OF GREENSIDE MINE.

There are three main ore-bodies in the lode, all inclined northward and extending over a total length of 260 fm. ; they have now been proved to a depth of 120 fm. below the Lucy Tongue level, or 1,600 ft. below the mean height of outcrop. They increase in length with depth, and as yet there appears to be no sign of deterioration ; in fact, the north ore-body, first discovered at outcrop, is said to be continuous and to have improved in depth. The south ore-body, bounded by the Clay vein, and similarly the smaller "middle" ore-body, is said to be more erratic and to be either very rich or very poor.

In the workings now abandoned, the low level, 82 fm. above the Lucy Tongue level, was the most important ; the connecting shaft is now used for transmitting power by electric cable. The Lucy Tongue level, at 1,100 ft. above O.D., begins on the Lucy Tongue vein (east of and parallel to the Greenside lode), along which it was continued until

the Clay vein was cut; after following this westward for some distance the miners found themselves too far south of the ore-producing ground proved in the upper levels of the Greenside vein; the direction was therefore again changed to N.W. and the level continued as a cross-cut until it met the main lode. The meandering adit thereby made is ¾ mile long and took 17 years to drive. From the Lucy Tongue level a vertical shaft was sunk to the 90 fm. level, from which an inclined skip shaft on the vein will shortly be completed to the 120 fm. level. From these shafts levels are driven off north and south 15 fm. apart, and the vein is worked out by means of headings or lifts from roof to sole, with the exception of arches or "cranches." All material is conveyed by tram to the shafts. At the Lucy Tongue level these are made into 12-wagon trains and drawn out by an electric locomotive. The ore is tipped near the mouth of the adit, the deads are picked out, and the rest loaded into tubs and hauled up an incline to the dressing-floors, these having originally been built to serve the higher levels. After passing through a rock-breaker and three pairs of crushing rolls the material is then trommelled, the sizes passing to the jigs (five three-compartment and one four-compartment) which, owing to the rather coarse nature of the ore, give very clean chats or ore-free residues. The rejects from the trommels go to two Huntington mills, and, after sizing, the coarse is jigged in five three-compartment jigs, the fines being treated on tables (four Record, two Luhrig, and four double-belt vanner tables). Slimes from the settling-pits are treated at intervals in buddles, of which eight are in use. The galena is dressed to an 82½% concentration; until recently it was smelted at the mine and the lead desilverized, but these works (started between 1830–40) are now disused, as they cannot compete with modern smelters.

Greenside mine is fortunate in having an abundant supply of water at high elevations; advantage has been taken of this to generate electricity for lighting and underground power, the mine being a pioneer in the North of England in this respect. Red Tarn and Kepple Cove Tarn on the flanks of Helvellyn are utilized as reservoirs, and the power-station (Gilkes turbine-dynamo) is situated at the base of Catchedecam. The water is taken at 1,750 ft. above O.D., and flowing through leats and pipes gives a fall at the generating station equivalent to a vertical head of 400 ft., with an effective horse-power of about 200. The current, at 2,000 volts, is conveyed through old workings to the Lucy Tongue level, where it is transformed to 600 volts for hoists and pumps and 250 volts for the electric locomotive. The waste water from the power station is used for the dressing-plant, which it also drives by means of water-turbines, subsequently going to a large water-wheel just below the mine buildings; this works the compressor for the six rock-drills and drives the saw-mill, etc. Transport is by road to Troutbeck station (C.K. & P. Ry.), a distance of about 9 miles.

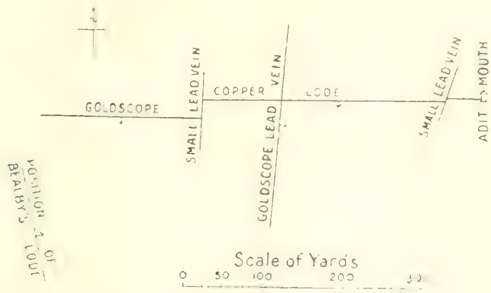
Brundholme. — This mine (with Blencathra) is situated in Glenderaterra valley, a little south of Roughten Gill, north-east of Keswick. The earliest mining—done about 1820—was near Roughten Gill. Levels were driven northward on two veins. A shaft was sunk below adit-level, but the workings were abandoned. About 1850 a shaft was sunk to a depth of 20 or 25 fm. on the eastern side of the stream, about ½ mile south of Roughten Gill, but lack of capital led to the mine (then known as "Blencathra") being abandoned, though some good ore was obtained. The vein lies 12 fm. east of the shaft. Some distance to the north it is said to become broken. To the south it has not been proved. Short levels have been driven lower down the valley to attempt to cut the western vein, but were abandoned before doing so. In 1872 work was recommenced about 300 yd. south of Roughten Gill, and a shaft sunk to 30 fm., with levels north and south at 20 and 30 fm. from the surface, but the mine was soon closed again. After an interval of many years the mine was reopened; the levels begun in 1872 were pushed out to the south, and a run of ore was found about 40 fm. south of the shaft. A rise has been worked up in this part of the mine from the 30 fm. level through and above the 20 fm. level. The mine was again abandoned some years ago, though periodic trials have been made. Recently it has been reopened by the Brundholme Co., first under the management of B. Johns, and lately under W. H. Borlase.

There are two main veins, one running a little east-of-north from the foot of Lonscale Crags to Roughten Gill (where it splits into strings), and the other a little west-of-north and coursing southward from Sinen Gill. These two intersect about 100 yd. south of the junction of Roughten Gill with the main stream; and to the south, near the old Blencathra mine (where they are about 120 yd. apart), are united by a small cross-vein bearing E.N.E. and W.S.W. These veins traverse Skiddaw Slates, in the aureole around the Skiddaw Granite, into unaltered strata on the south. The veins are filled with rock fragments and quartz, and variable amounts of barytes, galena, and copper pyrites with some cerussite, malachite, and chrysocolla. The northern parts of the veins, between Sinen and Roughten Gills, are said to have yielded mainly copper pyrites, but farther south galena prevails accompanied by barytes; the latter mineral is white and apparently of good quality. The small amount of copper found on the south usually appears in patches in the middle of the vein, surrounded by galena and barytes. It is said that the ore-bodies frequently appeared rich and promising, but, on further investigation, proved disappointingly small; in addition, the lodes are low-lying and require shafts with pumping and haulage machinery, so that operations are costly and, as a rule, of short duration. The Brundholme Company have recently sunk a new shaft to 35 fm. and raised a little barytes and lead ore, but work is still largely in the stage of development. Pumping by water-wheel is carried out from the northern shaft. Ore is raised in kibbles by a small steam-engine. A rather rough mountain road leads to Threlkeld station, a distance of about 3 miles.

Goldscope or Newlands.—This property is situated about a mile south of Little Town in the Vale of Newlands, south of Keswick. Goldscope mine has had a long and varied career, being worked at first in the Middle Ages for copper ore. About the year 1850, the owners (Clarke & Co.) were extending the adit in search of further supplies, when they struck the "Great Lead Bunch" of the Goldscope lead vein. When first met with the richest part of this ore-body was 15 fm. long, with one rib of solid galena 3 ft. wide, in addition to

smaller ribs from 3 to 8 in. in width. The ore-body became less rich in depth, but extended in length to 45 fm. About the year 1866, when most of it had been extracted, the mine was abandoned and has remained closed until recently.

At Goldscope, a number of lead veins, ranging from N. to S. and N.N.E. to S.S.W., intersect and frequently displace an E. to W. copper lode. The most important are Sealby's lode and the Goldscope lead vein, which cross the western side of Scope End. The Goldscope lead vein (see illustration) hading easterly at 1 ft. to 18 in. per fm. from the vertical, crosses, but does not displace, the copper lode at a distance of 250 yd. from the entrance to the adit along the latter vein. The lead vein is poor and contracted at the surface, but improves in depth for some distance. The average width above the adit is about 5 ft., though in places it increases to as much as 12 ft., while below the adit it does not average more than 3 or 4 ft.



Sketch Plan of Adit at Goldscope.

Beyond the 80 fm. level the vein becomes somewhat confused, and in places, particularly west of the shaft, carries soft, sandy quartz 12 ft. in width. In the lowest workings, the vein is in parts 32 ft. in breadth, but here includes several horses of barren material. The only definite off-shoot from the lode is the "Borrowdale String," which splits off to the west at about adit-level and rejoins the main vein about 80 fm. deeper. The intersection of the copper and lead vein was the richest part of the mine and was known as the "Great Lead Bunch," but away from the junction the lode does not carry much ore. The length of this rich ore-body proved to be short—from 15 to 45 fm.—extending to a depth of 90 fm. below the adit, but becoming poorer and not worth working below that level. When this ore-body was exhausted and explorations to the north and south had failed to locate other workable bodies, though patches of galena were met with, the mining of this vein was abandoned.

The vein-filling consists of variable amounts of quartz, sometimes 3 or 4 ft. wide, and smashed country rock (Skiddaw Slates), with, in places, a considerable amount of blue clayey ground or "douk." There is a little blende, but galena is the only ore of economic importance. The silver content is low, generally 7 or 8 oz. per ton of pig lead. Galena occurs chiefly on the foot-wall side in solid ribs and bunches; one mass from the richest part is said to have contained 50 cu. yd. of solid galena. Where the vein contains douk, galena is found in blocks or bunches in the clay. At the south end of the mine the Borrowdale String, in the 60 fm. level, contained flat beds of galena about 9 in. thick, which were easily lifted by crowbars from a soft matrix of quartz.

At the time Mr. Eastwood's report was written, the autumn of 1919, a certain amount of galena was being obtained from ground rushing-in from what was believed to be a string from the Goldscope lead vein, not far from the top of the old shaft. It was not easy to maintain the workings, which are in treacherous collapsible ground. The galena here occurs in blocks up to a cubic foot in volume and receives no dressing beyond cobbing.

Sealby's lode, hading parallel to the Goldscope lead vein and west of it has never been properly opened out, but the adit on the copper vein is now being pushed forward in the hope of intersecting a rich ore-body at the junction. The Sealby lode, though sometimes 6 or 7 ft. wide, is said to be smaller than the Goldscope lead vein and to contain more sandy quartz. Galena generally occurs as blocks, balls, and bunches in this soft matrix. The lode was worked at the surface to a limited extent, south of the line of the copper adit and from 20 to 60 fm. west of the Goldscope lead vein; apparently it swings away northward, as at the time of examination by Mr. Eastwood (September 22, 1919) the adit was already 305 yd. beyond the latter vein and had not then intersected Sealby's lode.

In the adit, 95 yd. west of the Goldscope lead vein, the copper lode is shifted 24 yd. to the south by an unnamed lead vein which runs approximately N. and S. and is almost vertical; it has been stoped out for a short distance above the adit, where it was 3 to 4 ft. in thickness. Farther east, about 44 yd. from the entrance to the adit, the copper lode is shifted a few feet southward by another lead vein, too small to be worth working.

The Goldscope vein, below the adit, was worked by means of a shaft with levels at intervals of 10 fm. Water for driving the wheel used for hoisting, etc., fixed at the top of the shaft in the adit, was carried into the mine by a leat from Scope Beck in Little Dale, and through a small back-level on the vein. A cross-cut north of the copper lode, commenced by Mr. Plummer, was never completed.

Water in Blister Copper. — In *Mining and Metallurgy* for October, Dr. Albert R. Ledoux draws attention to a fact that never appears to have been publicly discussed; namely, that blister copper will absorb moisture. Several years ago his firm was representing the Mount Lyell Company of Australia, which was shipping its blister copper to a refining works in the United States. After the contract had been running for many months, the superintendent of these works discovered that if water was poured upon the surface of the bars much of it would disappear into the interior through blow-holes. Some experiments made by him showed that this could be a considerable amount, so that copper which had been rained on before it was weighed, although the surface appeared dry, nevertheless would contain water. It had frequently occurred in Dr. Ledoux' firm's experience as samplers that the drillings from a lot taken by boring would come out quite wet, and in some cases, indeed, water would drip into the sample pan placed below the bars, due to the fact that the drill had penetrated a cavity or cavities containing water, which presumably got into the cavities at

the time the copper was water-cooled after casting, there being, perhaps, no outlet to the surface. Until this discovery at the refining works, no one had thought that rain could penetrate into the interior of blister copper, at least in any quantity sufficient to be considered.

Some experiments were made at the works in question, which showed that the bars would lose about 0·2 or 0·3% of moisture when dried in the furnace. Thereafter, to save the trouble of determining this water in every lot, an average figure was agreed upon, which was deducted from the weight, in settlement. Gradually this fact became known at other refineries, until now it has become the universal custom to stipulate in the contract that moisture shall be determined in each case.

Dr. Ledoux gives photographs of blister copper sawn across. The cavities shown in these photographs, while not extending in most cases to any great depth, are frequently quite capacious in horizontal extension. One bar after being weighed separately had the surface sprinkled with water to simulate a shower, and was allowed to dry in a hot sun until there was no sign of surface dampness. It was found on a second weighing that the weight had increased from about 242 lb. to about 242¾ lb. A second bar similarly treated increased from about 252 lb. to about 253 lb. On another bar a dam was made round a small orifice, and through this small hole over a teacupful of water disappeared into the interior.

When the practice of determining this occluded moisture was developed, each works devised a furnace for drying, in accordance with the ideas of its technical experts, and the practice differs in each case. In one works, for instance, to-day, the sample bars chosen for the moisture determination are placed upon an iron car having no closed bottom, simply a grating on which the bars are placed. This car, after weighing, is run into a furnace heated by steam coils at a pressure of about 120 lb., which is equivalent to something over 300° F. In other cases the car is run into a furnace heated by coal or coke; in others the heat is obtained from oil and a pyrometer is employed, the heat being allowed to rise as high as 600° F. in some instances. It has been found that when the iron or steel car is run into a furnace, the car itself will lose in weight, partly because the contraction and expansion of the metal of which it is built will cause scale of iron to fall off, and, in addition, whatever grease or oil is used in lubricating the axles is partly distilled off by the heat, so that the car weighs less when coming out of the furnace than when it went in. In one works this loss has been determined by weighing a number of cars, then introducing them into a furnace empty, and weighing them again after several hours of exposure to the heat. The loss in weight ran from 0·1 lb. to 1 lb. as a maximum. If this loss in weight of the car had not been determined and allowed for, it would have been counted as moisture when the loaded car was re-weighed after drying the bars upon it. In one of the most recently constructed drying ovens no car is run into the furnace at all; the bars to be used in the moisture determination are weighed on a scale close to the drying oven; then the bars are lifted and placed upon a conveyor, which runs into the furnace under electrical control. After exposure to the heat from the oil, the flame is turned off, the doors of the furnace thrown open, and when the metal has been thus partly cooled, the direction of the chain is reversed, the copper brought outside, and the cooling completed in the open air.

It has been suggested that perhaps copper would be oxidized if exposed to a sufficiently high temperature, under red heat, but whether this be so or not, the increase in weight in the heated copper would inure to the benefit of the producers rather than to that of the refiners, and the same is true of the slight coating of lamp black which is sometimes found on the bars after heating in an oil-burning furnace.

Recent analyses of various bars of this character show that the moisture varies from about 0·02% to about 0·8%, which is equivalent to 0·4 lb. and 16 lb. respectively per ton of metal.

Kata-thermometer Observations in New Zealand.—The Annual Report of the New Zealand Mines Department contains a paper by Frank Reed, Inspecting Engineer and Chief Inspector of Coal Mines, describing the application of the kata-thermometer in observing the physiological conditions in some of the deeper mines in New Zealand.

A considerable amount of controversy has taken place in New Zealand mining circles regarding the provision contained in Regulation 94 (7) (*c*), under the Mining Act, that the maximum temperature of air in any working-place in any mine in the Hauraki Mining District, measured by a wet-bulb thermometer, shall not exceed 83° F., unless firing of explosives has occurred in such place within twenty minutes of the observation of the thermometer, though the Inspector of Mines may allow such higher temperature if in his opinion it is impracticable to maintain the temperature at or below 83° F., wet-bulb; but he shall fix the number of hours (not exceeding six) which any person shall be employed in any such working-places. As depth is attained at the Waihi mines it has occasionally been found impracticable to maintain the temperature below the above standard, the rate of increment of the temperature of the rocks with depth being approximately 1° F. in 33 ft. The wet-bulb temperature of the workings at times has approached 90° F., which temperature has been pronounced injurious to men at work by Dr. J. S. Haldane and other eminent physiologists.

With a view of ascertaining to what extent the conditions existing in hot and humid working-places may be improved by the circulation of air at increased velocity, a number of observations have been recently taken by some mining engineers, consisting of M. Paul, Inspector of Mines; A. H. V. Morgan, Director of Waihi School of Mines; E. G. Banks, superintendent, and J. L. Gilmour, manager, of the Waihi gold mine; W. McConachie, manager of the Waihi Grand Junction gold mine; and by Mr. Reed. The observations were principally taken for the purpose of establishing, if possible, a kata-thermometer standard for warm mines as an improvement on the existing wet-bulb thermometer standard. The places of observations were specially chosen where the velocity of the air for experimental purposes could be regulated and increased when desired, and do not always represent the working conditions of the mines.

Upon reference to the tabulation of the results of Series "A," "B," and "C" thus obtained it will be seen how rapidly the cooling power, as indicated by the kata-thermometer, improved with increased air velocity, as shown by

TABLE OF RESULTS OF OBSERVATIONS TAKEN TO ASCERTAIN THE PHYSIOLOGICAL CONDITIONS AT SOME MINES IN NEW ZEALAND.
The instruments used consisted of Dr. Hill's kata-thermometer, the Biram-Davis anemometer, and the Sling hygrometer.

Number of Observation.		Place of Observation.	Date.	Outdoor Temperature in Shade.		Temperature at Place.		Kata-thermometer: Cooling-power in Milli-Calories per Sq. cm. per sec.		Velocity of Air in Feet per second.	Physiological Conditions as believed by the Mining Engineers present at the Tests.
				Wet Bulb.	Dry Bulb.	Wet Bulb.	Dry Bulb.	Wet Bulb.	Dry Bulb		
				°F.	°F.	°F.	°F.				
	1	Seatoun, Wellington, on coastal hill.	18/1/22	56·60	65·00	56·60	65·00	57·60	24·90	14·30	A strong but salubrious breeze outside; conditions not objectionable for arduous physical work.
		Waihi Gold Mine—									
Series "A"	2	No. 13 (1,450 ft. level, Martha lode west	28/1/22	61·50	62·30	80·25	81·40	9·40	2·90	Still air	Oppressive.
	3	No. 13 (1,450 ft.) level ..	28/1/22	61·50	62·30	78·60	80·20	33·20	15·00	12·90	Velocity of air excessive for continual physical work in a mine.
Series "B"	4	Royal lode west..........	30/1/22	59·00	64·00	88·00	88·70	4·90	1·57	Still air	Extremely oppressive conditions and unendurable, inducing profuse perspiration on unclothed men resting.
	5	,, ...	30/1/22	59·00	64·00	84·70	88·00	21·80	4·46	6·00	Velocity of air rendered conditions satisfactory for physical work.
	6	,, ...	30/1/22	59·00	64·00	83·00	87·00	27·10	6·30	11·85	Velocity of air excessive.
	7	900 ft. level, Edward lode, White's stope	14/3/22	58·00	67·50	78·00	79·50	11·10	4·04	0·70	Lower limit of satisfactory conditions, velocity just sufficient to deflect candle-flame.
	8	1,150 ft. level, Edward lode, Heath's stope	14/3/22	58·00	67·50	76·50	77·50	12·40	5·04	0·54	Satisfactory stoping conditions.
	9	1,265 ft. level, Edward lode, Harrison's stope	14/3/22	58·00	67·50	77·00	77·50	10·60	4·07	0·42	Lower limit of satisfactory conditions.
	10	Edward lode, Salmon cross-cut	14/3/22	58·00	67·50	79·00	81·00	24·20	11·30	12·60	Satisfactory conditions.
Series "C"	11	Waihi Grand Junction Gold Mine, No. 7 (1,200 ft. level), south-east cross-cut to Empire lode	31/1/22	62·50	67·00	76·00	77·00	11·70	4·42	0·65	Considered reasonable working-conditions for naturally hot mines.
	12	Ditto	31/1/22	62·50	67·00	72·00	74·50	19·20	8·30	18·3	Good conditions for working in naturally hot mines.
	13	Taupiri Extended Colliery, No. 1 west dip heading, 300 ft. deep	6/2/22	64·00	78·00	64·50	66·70	17·01	6·21	Still air	Fair conditions. Of the two miners working only one had his shirt off. Considered to be the warmest place in the colliery: if so, colliery workings on the Waikato coalfield are reasonably cool.

observations Nos. 2 and 3, being Series "A" taken at the same point; Nos. 4, 5, and 6, Series "B" taken at one point; and Nos. 11 and 12, Series "C" at one point, increasing through each series the velocities from still air. The opinions expressed on the physiological conditions contained in the last column were conscientiously arrived at by the mining engineers, who base their opinions upon what they believed to be the conditions existing; but when compared with the standard of the inventor of the kata-thermometer, Dr. Hill (namely, that for sedentary workers the dry kata-thermometer should be kept not less than 6 and the wet 16·5, but that the cooling power should be higher than these for severer forms of mechanical work), the standard here adopted by the New Zealand engineers (4·04 dry kata-thermometer and 10·6 wet kata-thermometer) are much less exacting, and, not being subject to medical analysis, cannot claim equal authority to Dr. Hill's standard. Thus, for the present, insufficient evidence exists by which to determine a legal kata-thermometer standard for mines. The observations, however, are of considerable value in showing the benefit of moving air at the working-places; likewise, observation No. 13, taken in still air in the warmest place in the warmest colliery in the North Island, provides satisfactory evidence that the temperature of New Zealand coal mines is not excessive.

Alumina from Clay.—Report No. 2393 issued by the United States Bureau of Mines contains a description of Paul Miguet's proposed process for extracting alumina from clay, and an account of tests made for the Bureau by C. E. Williams and C. E. Simms. Their results were not encouraging and their criticisms are adverse. As the extraction of alumina from clay is alluring to the inventor and in fact constitutes one of the most important metallurgical problems for the future, we quote herewith from this report.

Mr. Miguet proposes to prepare alkaline aluminate by fusing clay, lime, and scrap iron with a reducing agent in the electric furnace, thereby reducing the silica and forming calcium aluminate and ferro-silicon. The calcium aluminate, being lighter, would float on top substantially free from foreign oxides. It could then be tapped off, cooled, and later crushed and leached with sodium carbonate solution to form, by double decomposition, sodium aluminate and calcium carbonate. The former is soluble and yields readily aluminium hydroxide. The ferro-silicon would be recovered as such and sold at a profit. The reactions are supposedly as follows:—

(1) $Al_2O_3 . 2SiO_2 . 2H_2O + Fe + 4C + CaO = FeSi_2 + 4CO + CaO . Al_2O_3 + 2H_2O$.

(2) $CaO . Al_2O_3 + Na_2CO_3 = CaCO_3 + Na_2O . Al_2O_3$.

So many reactions similar to the above have

been proposed, and it is so popularly believed that alumina can be obtained from clay by fusion, that the Northwest experiment station of the Bureau of Mines at Seattle undertook to investigate the Miguet process. The tests were carried out in a carbon-lined pit furnace of the Girod type, having a tap hole to remove the fused material. Clay containing 38% alumina, pure air-slaked lime, steel turnings, and gas retort carbon were used. These materials were finely ground, intimately mixed, wetted, and dried in lumps to avoid dust. In the first tests the charges were made up with clay, lime, iron, and carbon in theoretical proportions according to the Miguet patent. The charge melted down readily and when melted was tapped. The analysis showed only a slight reduction of silica, and it was thought that possibly insufficient time had been allowed for reduction. The test was therefore repeated, the charge being held molten for a considerable time before tapping. No increase was noted in the amount of silica reduced. When the product was crushed and leached with a hot concentrated solution of sodium carbonate, only a trace of alumina and fully as much ferrous iron was found in solution. When the proportion of lime was increased, it merely increased the melting point and gave no better product. In these first tests an effort was made to keep within the limits of commercial practicability, but having failed to obtain any favourable results, these restrictions were cast aside and tests were made to determine what was technically possible. The proportion of lime, carbon, and iron to clay was increased to speed up their action on the clay, and the charge after fusion was heated to 1,800° C. and held for 30 minutes. Still results were unsatisfactory. A charge was then made up with carbon three times, and iron twice the theoretical quantity. The purpose was to subject the charge to the most intense reducing conditions possible, and silica is known to reduce more readily in the presence of iron. The charge was melted with the furnace over-powered to such an extent that dense fumes arose. The product obtained was black and stony, hard enough to scratch glass easily. On examination it was found to contain carbides of calcium, aluminium, and silicon, sillimanite, and quantities of a glassy substance. The analysis showed that about 40% of the silicon had been reduced and alloyed with the iron. The product of this final fusion, when leached with sodium carbonate, gave a recovery of about 30% of the alumina. This alumina produced contained 0·6% SiO_2.

The fact that alumina was actually produced gives some small basis for the claims of the patent, but the prospects of its successful applications are extremely poor. In the first place, to produce alumina by the method of the most favourable test, the cost of the material alone would be more than $300 per ton, as the minimum figure. Moreover, there is no proof that calcium aluminate was formed, because, with so much carbide present, it is just as likely that the sodium aluminate obtained was formed by the decomposition of aluminium carbide and its subsequent solution in the sodium carbonate. It is certain, too, that silica is not alone in being acted upon by the carbon, but that all the other oxides will also be reduced in varying degrees.

Canadian China-Clay. — The *Canadian Mining Journal* for August 11 gives an account of the china-clay industry established at Huberdeau, Quebec, about 70 miles north-west of Montreal. This district was examined by Dr. M. E. Wilson in 1916 and 1918 for the Geological Survey, and his report (Memoir 113, Amherst Township Minerals) deals with the geology of the deposits. The china-clay was first reported in the district in 1895, when a sample was obtained from the bottom of a well. As there are few natural outcrops of rock in the vicinity, all being covered by a thick layer of glacial drift, prospecting is expensive and development has thus been retarded. Ten years ago the Canadian China-Clay Company acquired a large acreage of the kaolin-bearing ground and erected a washing plant. Several thousand tons of china-clay was produced under the original management. The management was changed and the plant altered, with less satisfactory results. Eighteen months ago a third management was inaugurated, and the operations since then have been consistent and effective, and promise to be not only commercially successful, but to lay a solid foundation for a Canadian china-clay industry.

The deposits occur in a quartzite rock of the Grenville series, the oldest series of rocks known to have a sedimentary origin. This quartzite was originally sandstone, and with it were associated beds of shale, which are now changed to garnet gneiss. This garnet gneiss occurs in an irregular way throughout the quartzite, and as it is iron-bearing, it introduces material that contaminates the quartzite and clay with rust. But there are zones that are free from the influence of this garnet gneiss, and consequently free from iron. The dip of the quartzite is vertical or nearly so. The zone in which the kaolin occurs is about 1,000 ft. wide, and is known to extend, north and south, for a distance of 7,000 ft. How far the zone extends beyond the limit is not known. Comparatively little surface prospecting has been done to disclose what lies beneath the mantle of boulder clay that effectually covers the ground. The clay-bearing zone is enclosed by a mass of intrusive granite, younger than the Grenville series, which provides a suggestion as to the origin of the kaolin deposits.

As the china-clay occurs in veins and pockets in the quartzite rock, and since in some zones it actually replaces the particles of rock, it is obvious that it must have been brought into its present position from without. The quartzite has been much folded, faulted, and shattered, thus providing the interstices in which the clay has lodged. There is, thus far, no evidence to show conclusively whether the clay was concentrated in its present position from rocks that at one time covered the present surface, whence it was leached by surface agencies, or whether it was brought up from below by means of ascending hot solutions. The proximity of the large masses of intrusive granite tends to support the latter theory ; and if so, the chances for the extension of the clay deposits to great depths are favourable. A deposit due to the action of superficial agencies would be limited in depth.

As indicated above, the china-clay is associated with much-shattered vertical beds of quartzite rock. In places there are veinlets and veins of pure white clay, up to a foot or more in width ; but the bulk of the clay occurs in admixture with particles of quartz, or filling little cavities in the quartzite. As commercial sources of clay, the veins are too small to work alone, and the quartzite

rock, which contains on an average 11% of clay, is too lean, though there is a very large quantity of it available. Hence the commercial possibilities at present are confined to areas within the 1,000 ft. zone of quartzite rock where the proportion of clay is higher than the average. By no means can all the clay present in this zone be classed as china-clay. The larger part of what has been exposed up to the present is stained with iron and must be classed as fire-clay. This fire-clay has proved to be an excellent material for saggars.

Formerly the clay was won entirely from open-cuts and pits. Now, mining methods have been resorted to, and have proved completely satisfactory. One lens of china-clay has been developed so far by this means. The shaft is 100 ft. deep, and the drifts have disclosed a lens 200 ft. by 60 ft. The lens to the south has been developed only by an open-cut, and consequently is not so well defined. In the one lens there is now developed between the surface and the first level, 25,000 tons of china-clay, exclusive of the quartz with which it is mixed. The production from this lens to date has been 7,000 tons. Of fire-clay, 300,000 tons has been developed. A large quantity is still available by open-cut methods.

The process of preparing the crude china-clay for market is simple, as is the plant required. After being loosened with dynamite, the crude clay is trammed to the shaft and hoisted to the surface. The process of treatment consists in separating the clay from the grains of quartz and from stray chips. The ore is so friable that a log washer is sufficient to disintegrate it thoroughly. A large part of the quartz, as coarse sand, is shovelled out from the washer. The flow of water carries fine sand with the clay through two long series of troughs, each series being about 500 ft. in length, where even the finest sand has a chance to settle out. The clay-bearing water is now run through a revolving screen to remove chips, and then into large settling tanks, which are filled in succession. Here the liquid is allowed to stand for 24 hours or more, by which time the supernatant liquid is clear and is decanted to return to the circuit. The thickened pulp in the bottom of the settling tank, called "clay slip," is now pumped at 100 lb. pressure through filter-presses, the filtered water being returned to the circuit. The filter cakes, containing about 25% moisture, are placed on racks and wheeled in car-loads into a drying tunnel, through which is blown a stream of air heated by steam coils. When thoroughly dry, the filter cake is broken to lumps and elevated to a large storage bin, ready for market. The present capacity of the plant is 10 tons of washed clay per day of 18 hours. Preparation is being made to alter this treatment method with a view of economizing labour and power and increasing the output. A sand pump will be installed at the bottom of the shaft to elevate the crude ore, with the mine water, to the surface. This will eliminate the need for the log washer. The pulp thus elevated will be passed through cone classifiers, which will eliminate not only the coarse sand now taken from the log washer, but a large part of the finer sand now caught in the settling troughs.

The clay is of a pure white colour, and its content of iron is less than that of the best Cornish clay imported into Canada. Its content of grit is unusually low, being about 0·08% in the form of fine particles of quartz not over 0·05 mm. in size.

SHORT NOTICES

Aerial Ropeway.—In a paper read on October 7 before the North of England Institute of Mining and Mechanical Engineers, R. S. Tate described the bi-cable ropeway installed by R. White & Sons, Ltd., at the Trimdon Grange colliery.

Wire-Rope Haulage. — The *Iron and Coal Trades Review* for October 6 publishes a paper on wire-rope caps and a new method of capping read by S. W. Richards on September 23 before the South Wales branch of the National Association of Colliery Managers.

Wave-Transmission of Power.—At the meeting of the North Staffordshire Institute of Mining Engineers held on October 9, W. Dinwoodie read a paper on the Wave-Transmission of Power.

Electrical Prospecting. — In the *Engineering and Mining Journal-Press* for October 7 and 14, S. F. Kelly describes field work at various metal mines in connexion with electrical prospecting.

Disc Crusher.—In the *Engineering and Mining Journal-Press* for September 23, David Cole gives an illustrated account of the development of the Symons vertical disc crusher.

Flotation. — In the *Engineering and Mining Journal-Press* for September 30, F. A. Sundt gives particulars of the Sundt-Diaz flotation machine used at the Corocoro copper mine, Bolivia. It is of the Callow and Inspiration type.

Flotation. — The *Engineering and Mining Journal-Press* for October 14 contains a paper by J. P. MacFadden on flotation methods on the lead-zinc ores of Slocan, British Columbia.

Nickel-Copper Ores. — The August *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa contains a paper by J. A. Ortlepp recounting investigations into the commercial treatment of the copper-nickel ores of the Rustenburg district, Transvaal.

Pyritic Smelting. — In the *Engineering and Mining Journal-Press* for October 7, E. C. King describes a proposed method of pyritic smelting in a reverbatory furnace.

Pyritic Smelting. — In the *Engineering and Mining Journal-Press* for September 30, C. Offerhaus describes pyritic smelting practice at the Siemens-Kwarzcharia copper smelter, Caucasus.

Powdered Coal in Lead-Smelting.—In *Mining and Metallurgy* for October, E. H. Hamilton describes experimental work at the Midvale smelter, Utah, with the use of coal dust in lead smelting.

Electrolytic Iron. — In the *Canadian Mining Journal* for October 6, A. Estelle describes his process for producing iron electrically from sulphide, pointing out that his work ante-dated that of Eustis, described in an article quoted in the MAGAZINE for January last.

Vanadium. — The *Journal of Industrial and Engineering Chemistry* for October contains a paper by B. D. Saklatwalla on the technical chemistry of vanadium, with an account of its reduction from ore.

Igneous Magmas. — In the *Journal of Geology* for September, N. L. Bowen writes on the dissolution of matter by igneous magmas.

Origin of Iron Ores. — In *Economic Geology* for September, J. W. Gruner discusses the origin of the Biwabik formation of the Mesabi range.

Broken Hill Geology. — In *Economic Geology* for September, E. C. Andrews gives an outline of the geology of the Broken Hill district.

Pyrites in Norway. — At the October meeting of the Institution of Mining and Metallurgy, H. H. Smith presented a paper describing the Skorovas iron pyrites deposit, north-east of Trondhjem, giving details of its exploration and development. The amount of ore so far proved is 3,150,000 tons, averaging 46·4% sulphur, 1% copper, 0·89% zinc, and 0·04% arsenic.

Spanish Lead. — The *Engineering and Mining Journal-Press* for October 14 contains a paper by E. A. Ritter on the Linares and La Carolina lead-mining districts in the south of Spain.

Ontario Geology. — In the *Journal of Geology* for September, E. L. Bruce discusses the classification of the Pre-Cambrian rocks of Northern Ontario and Northern Manitoba.

Oil Wells. — At the October meeting of the Institution of Mining and Metalluıgy, H. C. B. Hickling described the method of controlling the flow of oil at the Apex Trinidad oil wells, the particular object being to prevent fine sand coming up with the oil.

Oil-Drilling. — In *Mining and Metallurgy* for October, J. H. Suman describes methods for taking cores in rotary oil-drilling operations, giving details of the Reed and Hepler, Oilfields-Holland, Knapp, and Acme tools.

Testing Petroleum. — At the meeting of the Institution of Petroleum Technologists held on October 10, A. E. Dunstan read a paper on Standardization of the Testing of Petroleum and its Products.

Mining Education. — In the *Engineering and Mining Journal-Press* for October 14, G. J. Young gives an outline of the mining and metallurgical curriculum at Yale University.

Dr. F. H. Hatch.—The *Engineering and Mining Journal-Press* for October 14 contains a biographical notice of Dr. F. H. Hatch.

RECENT PATENTS PUBLISHED

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.*

7,747 of 1921 (185,439). UNIVERSAL OIL PRODUCTS Co., Chicago. Method of cracking heavy oils for the production of petrol.

15,047 of 1921 (185,808). W. J. AIKENS, Dunville, Ontario. In the electrolytic refining of tin, the addition of phosphoric acid to the electrolyte so as to precipitate lead, and of cresylic acid to prevent hairy growth of tin crystals.

15,066 of 1921 (185,216). W. W. STENNING, W. H. BEASLEY, and MINERALS SEPARATION, LTD., London. Improvements in the manufacture of briquettes from finely powdered coal.

16,148 of 1921 (185,842). R. E. PEARSON, E. N. CRAIG, and DURELCO, LTD., London. Electrolytic method of extracting tungsten and molybdenum from ores and waste products.

16,404 of 1921 (186,114). NATIONAL LEAD Co., New York. Improvements in the continuous process of making white lead by treating pulverized lead in a rotating cylinder with the necessary corroding agent.

16,456 of 1921 (186,118). SOCIÉTÉ THOUMYRE FILS, Paris. Adding small amounts of ferro-manganese to lead-antimony alloys in order to increase their strength, hardness, and tenacity.

16,489 of 1921 (185,859). N. V. HYBINETTE and R. L. PEEK, Ottawa. Improvements in the precipitation of copper from solutions containing nickel and copper sulphates.

16,913 of 1921 (186,143). F. G. PRICE, and MINERALS SEPARATION, LTD., London. Method for the differential flotation of the various descriptions of coal, particularly with the object of preventing the flotation of the fusain constituent which is not serviceable in coke-making but is useful in briquette manufacture.

17,099 of 1921 (186,162). B. A. MITCHELL, Salt Lake City. A gyratory ore crusher in which the crushing pressure is produced by the centrifugal action of a loose revolving weight.

19,113 of 1921 (186,199). DR. H. PLAUSON, Hamburg. In the extraction of potash from felspar, in order to hasten the action of the hydrochloric acid, reducing the felspar to colloidal fineness dispersed through water or alkaline solution.

21,662 of 1921 (185,313). B. FELDER-CLEMENT Co., Lucerne, Switzerland. Method of producing carbide of tungsten containing no free carbon.

21,872 of 1921 (185,315). INTERNATIONAL PRECIPITATION Co., Los Angeles, California. Improvements in electrostatic precipitation of fume, etc., from gases, particularly in connexion with the treatment of hot gases from furnaces.

22,803 of 1921 (185,624). J. A. STONE, Washington, U.S.A. A method of cracking heavy oils for the production of petrol, according to which the carbon formed is utilized by burning and so producing heat required in the cracking process.

24,843 of 1921 (186,253). W. BOEHM, Berlin. Improved practice in rolling magnesium into thin sheet or foil.

33,151 of 1921 (174,046). SIEMENS-SCHUCKERTWERKE, Berlin. Transformers for use in electrostatic precipitation of fume from gases.

4,435 of 1922 (176,770). G. A. BLANC, Rome. Method of separating chlorides of aluminium and potassium obtained by treating leucite with hydrochloric acid.

NEW BOOKS, PAMPHLETS, Etc.

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

Coal, Coke, and By-Products, 1913–1919, Part III. Report published by the Imperial Mineral Resources Bureau. Price 7s. net. This report deals with the production and resources of foreign countries.

Iron-Ore ; Part 6, Europe and Foreign Africa. Published by the Imperial Mineral Resources Bureau. Price 6s. net.

Stone Dusting of Mines, Part II. By F. S. SINNATT, A. McCULLOCH, and J. R. LOMAX. Pamphlet, 30 pages. Price 2s. net. London : H. F. and G. Witherby.

A Comparison of British and American Foundry Practice, with Special Reference to the Use of Refractory Sands. By DR. P. G. H. BOSWELL. Paper covers, octavo, 106 pages. Price 4s. 6d. net. Liverpool : The University Press ; London : Hodder & Stoughton, Ltd.

Researches on the Constitution of Coal. By S. ROY ILLINGWORTH. Paper covers, octavo, 62 pages. Price 2s. 6d. net. London : The *Colliery Guardian*.

The Shape of Pebbles. By C. K. WENTWORTH. Bulletin 730 C. published by the United States Geological Survey.

COMPANY REPORTS

North Anantapur Gold Mines.—This company was formed in 1908 by John Taylor & Sons, as a subsidiary of the Anantapur Gold Field, Ltd., for the purpose of working old gold mines at Anantapur, Madras Presidency, India. Milling commenced in 1910. Additional capital was raised in 1911, by the issue of preference shares, for the purpose of extending development. The scale of operations has not been great and the profits were never large. Five years ago developments began to give discouraging results. As reported recently, mining was suspended last July, and since then the gold output has come from a clean-up at the mill and from the cyanide treatment of old residues. The report for the year ended June 30 last shows that 7,000 tons of ore was sent to the stamps, where 7,211 oz. of gold was extracted, and that 8,450 tons of tailing was treated by cyanide for an extraction of 707 oz.; in addition, 524 oz. was won from an unspecified amount of old residues. The total yield of gold was 8,442 oz., which realized £42,432. The profit was £21,309, out of which £6,250 has been distributed as dividend on the £25,000 preference shares, and £4,562, or 5%, on the ordinary shares. The sum of £10,000 was placed to reserve. The cyanide plant is continuing the treatment of old residues, but these will probably be exhausted by January, 1923. Prospecting has recently been commenced at a new discovery of ancient gold workings 35 miles away from Anantapur. A financial interest has been taken in the Continental and General Exploration Co., Ltd., which has been formed to develop a gold-mining property in Sumatra, and similar steps have been taken in connexion with the Anglo-Canadian Explorers, Ltd. The company last year reported the acquisition of a copper property in Chota Nagpur. It is now reported that exploratory work is in hand, two shafts being sunk and an adit being driven, with a view of testing the lode in depth.

Broken Hill Proprietary.—This company has operated lead-zinc-silver mines at Broken Hill, New South Wales, since 1885, and more recently has established iron and steel works at Newcastle, N.S.W. The report for the year ended May 31 last shows that no underground work was done at Broken Hill owing to the impossibility of making a profit under the Edmunds labour award. The lead dressing plant was re-started on September 17, 1921, on dump tailings, and 184,701 tons of this material gave 2,789 tons of lead concentrate and 37,837 tons of slime. The zinc separation plant treated 144,207 tons of tailing, and produced 23,932 tons of zinc concentrate and 2,813 tons of slime. At the flotation plant employing the Bradford process, 122,611 tons of slime was treated, yielding 11,081 tons of lead concentrate and 28,837 tons of zinc concentrate. At the Newcastle works the output of pig iron was 235,165 tons and of steel ingots 219,799 tons. As already mentioned in the MAGAZINE these works are now idle as the high wages and other adverse labour conditions make it impossible for the company to compete against European producers. The net profit for the year was £103,300, and £92,053 was distributed as dividend, being at the rate of 9d. per £1 share.

Broken Hill South. — The report now issued covers the year ended June 30, 1922. During the first half of this period underground operations were limited to one shift per day, but with the improvement in the price of lead the output was increased to normal thereafter. Under the Edmunds labour award "normal" means 4,000 tons per week instead of a pre-war 6,500 tons. The award prohibits stoping on night shift and limits the effective working hours underground to about 27½ per man per week. During the year 164,730 tons of ore, averaging 14·4% lead, 13·1% zinc, and 6·8 oz. silver per ton, was sent to the lead concentration plant, at which the following were the valuable products: Lead concentrate, 25,149 tons, averaging 68·2% lead, 6·6% zinc, and 22·7 oz. silver; zinc tailing 89,074 tons, averaging 16·6% zinc, 3·4% lead, and 3·4 oz. silver; slime 28,188 tons, averaging 10·9% lead, 12·8% zinc, and 7·4 oz. silver. At No. 1 flotation plant the current slime was treated for a yield of 4,184 tons of lead concentrate, averaging 60% lead, 8·7% zinc, and 39·2 oz. silver; together with 24,004 tons of zinc tailing averaging 13·5% zinc, 2·4% lead, and 1·8 oz. silver. At No. 2 flotation plant, 141,440 tons of dump slime was treated for a yield of 24,991 tons of lead concentrate, averaging 44·1% lead, 16·3% zinc, and 31 oz. silver; together with 116,449 tons of zinc tailing, averaging 12·6% zinc, 4·4% lead, and 2 oz. silver. The total production of lead concentrate during the year was 54,324 tons, averaging 56·5% lead, 11·3% zinc, and 27·8 oz. silver. The company has not yet built its flotation plant for the treatment of zinc tailings, but the plant is to be ready for work by the end of 1923. Development continues to disclose ore, and the reserve is maintained at 3,500,000 tons. The net profit for the year was £235,747 after allowing for depreciation and taxation. Out of this balance £62,400 has been allocated to expenditure on the zinc plant. Dividends have been paid absorbing £160,000, being at the rate of 4s. per £1 share.

Naraguta (Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin property in the Bauchi Plateau, Northern Nigeria. Though the outputs of tin concentrate have been fairly large, the dividends have been variable, totalling only 80% in eleven years. The report for the year ended March 31 last shows that 618 tons of tin concentrate was produced, valued at £57,184, and that a net profit was made of £3,908, out of which £2,518 is due for income tax. As already recorded in the MAGAZINE, the company is developing a lode-gold property at Birnin Gwari.

Nigerian Consolidated. — This company was formed early in 1920 to acquire a number of alluvial tin properties in the Rayfield, Jemaa, and Womba districts of Northern Nigeria from the late W. E. Thomas. The report for the year ended February 28 last shows that operations were restricted so as to keep expenditure to the lowest possible figure, owing to the low market value of tin. The output of tin concentrate was 119 tons, and the credits were £17,046. The accounts show an adverse balance of £2,951. It is stated that the company has secured interests in alluvial and lode gold deposits, and that the prospecting so far carried out indicates that the interests are valuable.

Jumbo Gold.—This company belongs to the Lewis and Marks group and was formed in 1903 to acquire gold mining property north of Salisbury, Rhodesia. Milling commenced in 1906 and continued until 1917, when the deposit was exhausted. The company then acquired the Tip Top property, where milling commenced in January, 1921. The report now issued covers the year ended June 30

last. During this period 17,400 tons of ore was treated and 5,923 oz. of gold was extracted, yielding on sale £28,806. The balance of profit was £4,003. Prospecting on the Defiance claims gave unsatisfactory results and work has been discontinued.

Cam and Motor Gold Mining.—This company was formed in 1910 to work gold mines near Gatooma, Rhodesia. The ore is troublesome, as it contains arsenical pyrites and stibnite. The first treatment plant was described in the MAGAZINE for August, 1913, this consisting of dry-crushing, roasting, and cyaniding. The plant was closed at the end of 1918, and a new plant employing wet crushing, amalgamation, water-concentration, flotation, roasting, and cyaniding was started at the end of 1920. In the meantime development had been pushed and additional capital raised by reconstruction. The report for the year ended June 30 last shows that 168,700 tons of ore averaging 44s. 10d. per ton at par was crushed in ball-mills, and that 21,775 oz. of gold was extracted by amalgamation and 41,065 oz. extracted by the cyaniding of 20,120 tons of roasted table, blanket, and flotation concentrates. The total yield of gold was 62,840 oz., worth £266,444 at par, and realizing with premium £307,258, the recovery being 70%. The profit was £46,870, which is all written off under the headings of depreciation and preliminary and experimental expenses. The developments have given good results, and the reserve is estimated at 666,110 tons averaging 39s. 10d. with gold at par. Costs have been gradually reduced. Improvements are being made in metallurgical practice, and with finer grinding a better extraction has been possible, the most recent monthly return showing a recovery of 77%.

Renong Tin Dredging.—This company was formed in 1908 to work alluvial tin properties at the southern end of the Western Siamese States. Owing to the exhaustion of these properties, new areas were acquired in Selangor, Federated Malay States. In our August issue we recorded accidents to the dredge recently transferred to Selangor and to No. 3 dredge remaining at Renong. The report for the year ended June 30 last mentions that the dredge at Renong has been reconditioned and has resumed work, and that the salving of the dredge at the Selangor property is being undertaken by the company on behalf of the insurance underwriters. During the year under review, the two dredges at Renong treated 1,327,933 cu. yd. of ground for a yield of 725 tons of tin concentrate, and the dredge at the Selangor property treated 553,844 cu. yd. for a yield of 265 tons. The total yield was 991 tons. The life of the Renong property is nearing its end, but probably No. 1 dredge will work for a year and No. 3 for three years. The profit for the year, after providing for depreciation, was £8,817, out of which £3,750 was paid as dividend on the 15% preference shares.

Russo-Asiatic Consolidated.—This company was formed in 1919 to consolidate the interests of the Irtysh, Kyshtim, Tanalyk, and Russo-Canadian Corporations operating in Russia and Siberia. Leslie Urquhart is chairman. The report now issued covers the year 1921. Reference is made in our Editorial columns to the position as regards the Russian properties. The company has also interests in France, Algeria, and Nigeria, and particulars of these are given in the report.

The French property is at Villemagne in the Cevennes, and contains deposits of silver-lead. A new French company has been formed, called Compagnie des Mines de Villemagne, with a capital of 20,000,000 francs, in which the Russo-Asiatic will have a 78% interest. This French company has sufficient cash capital to complete development and equipment of the mine and reduction plant. A strong east-west lode extends through the property for several miles, with prominent outcrops well mineralized. On the westerly portion of this are the old Villemagne workings, comprising an adit and levels from which before the war ore was extracted that produced nearly 5,000 tons of concentrates, assaying 55% lead and 20 oz. silver per ton, as a result of imperfect methods of concentration. According to the estimates of the old company, there are 500,000 tons of developed ore remaining in this section of the property; no attempts have been made to reopen all of the old stopes and check this figure, but from examination of those that are accessible it is certain that there is a considerable tonnage of profitable ore to be won here, in addition to which the diamond-drill has recently disclosed valuable ore below the old workings. On the easterly portion of the Villemagne lode, 20 bore-holes have been put down cutting the ore at an average depth below the outcrop of 250 ft., and three have reached to 400 ft. or over. From this evidence it has been determined that the vein as cut has an average horizontal thickness of 11 ft. over a length of 4,000 ft., representing 400,000 tons per 100 ft. of vertical depth, or roughly 1,000,000 tons indicated above this horizon in the vein proper. Bore-holes under the old mine have cut ore nearly 600 ft. deeper, so that there is every prospect of a similar extension to depth in this new section. In addition, a feature of the occurrence is the existence of beds of ore outside the limits of the main fissure, but apparently owing their mineral contents to the same source as the vein. One of these has been largely worked in the old mine, and another has been cut by the diamond-drill below the old workings, while in the eastern section bore-holes have cut six of these of an average thickness of 15ft., assays from which indicate ore of materially higher value than that in the vein proper. The fact that each of these beds is cut by only a single bore-hole precludes calculations of tonnage at present, but there is no doubt of their large extent. By mixing the ore from these beds with the lower-grade ore from the main vein, a milling feed can be supplied which will, at present market prices of metals, yield a profit of about £2 per ton. The technical advisers have proposed an initial treatment unit having a capacity of 50,000 tons of ore per year, to be enlarged by similar units as development proceeds. In addition to the Villemagne vein proper, there are many other points on the property where mining has been prosecuted in the past and to which only cursory attention has as yet been paid by the new company. On one of these—the Serreyrede—in reality an eastern extension of the Villemagne fissure, diamond-drilling is now in progress, under some favourable outcrops. For some time past laboratory work on ore treatment has been carried out with wholly encouraging results, and it has been demonstrated that both lead and zinc concentrates of very good grade can be produced with a high recovery of metals. A test plant is now in course of erection, and on the data from this will be based the flow-sheet for the first unit of permanent plant, for much of which the machinery in the existing old mill will be used.

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The Mining Magazine

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CONTENTS

EDITORIAL

AMONG the papers read at the meeting of the Institution of Mining Engineers held last month, the most interesting from the point of view of the non-ferrous engineer was that by Mr. Alexander O. Brown on the heating and ignition of sulphides in mines. This is a subject always with us, but seldom discussed, so that Mr. Brown is to be specially thanked for giving so complete a statement of his experience in the south of Spain. His paper is quoted elsewhere in this issue. Another paper read at the same meeting by Professor Henry Briggs on heat developed in crushing will receive comment next month.

IT is not surprising that the Government should undertake an examination into the affairs of the proposed British Empire Exhibition to be held at Wembley in 1924. For one thing Wembley is the wrong place for the exhibition; the White City should have been acquired. Second, the Dominions are straining matters too far in demanding that materials used in construction and the food and drink supplied at the restaurants should be Empire products. Third, nothing has yet been done for making an adequate show of the Empire's mineral resources, an omission of fatal import.

Cassiterite in Laterite

In a short article published in this issue, Messrs. G. Gordon Thomas and J. L. Vitoria give a description of an occurrence of tin-bearing veins in the Liruie Hills, Northern Nigeria. These deposits are of considerable scientific interest, inasmuch as some of the veins are in laterite. The main veins contain cassiterite, wolfram, blende, copper pyrites, and columbite, in a quartz gangue, and they traverse the margins of an intrusive granite. In addition to these veins, there are irregular quartz stringers, containing cassiterite in a laterite overlying the granite. Presumably the granite has been lateritized in situ, while the quartz veins have been only partially attacked. To those who are familiar with the characteristics of laterite, the presence of these undigested stringers of quartz will be fairly well understood. Crystalline silica is remarkably insoluble at all times, even when exposed to lateritization conditions, and large fragments of quartz persist as corroded aggregates in the oldest laterites. The notable point in this case is that cassiterite should occur in association with the lateritized quartz, for it is a much more soluble mineral. One is led to the belief that the cassiterite in these stringers has been precipitated subsequently to the lateritization; that is to say, that it is not a primary constituent of the lateritized veins, but was deposited after the original tinstone of this part of the veins had been removed. The quartz stringers would by their disposition maintain regular channels for the passage of water up and down during the process of lateritization. Infiltrating waters would dissolve the soluble constituents, while upward percolating waters would carry the dissolved substances to the surface. In tropical countries where there is severe evaporation the spring waters would readily deposit the minerals held in solution, and in this way cassiterite would be brought upward into the zone above permanent ground-water level.

The dissolution and re-precipitation of cassiterite are processes which do not receive as much attention from the economic geologists as they deserve. Dr. J. Morrow Campbell and the late Mr. J. H. Collins have drawn attention to it, the former as recently as April last in this MAGAZINE. Mr. Collins published articles on the subject in the *Mineralogical Magazine* in 1880 and 1883, where he quoted cases of cassiterite being found as a cement in conglomerate, as pseudomorphs after felspar, as cappings to crystals of quartz, etc. We have ourselves suggested that rich surface tin ores are the results of upward concentration, and that a chemical process of enrichment continues in the Cornish tailing rivers. It is to be hoped that the writers of the present article will have further opportunity for studying this occurrence at Liruie in order that the mineralogical history of these stringers may be definitely ascertained. Or perhaps some other readers of the MAGAZINE may be inclined to give their views and experience in this connexion.

Canadian Iron Ores

The British possessions in the New World are singularly bare of iron ore deposits of commercial size and quality. The only large deposit now actually worked is that at Wabana, Newfoundland; this is a very extensive deposit, consisting mostly of hematite, and the ore is smelted chiefly at Sydney, Nova Scotia. In Canada, iron ores

of all kind are found widely distributed, but the deposits are small or of low grade, or are associated with objectionable minerals such as sulphides or titanium compounds. The various Provincial Governments do all in their power to encourage prospecting, development, and exploitation. For many years ventures and proposals have followed each other in a continuous stream, generally with unsuccessful results. Examinations by experts appointed by the Governments have been made from time to time. For instance, Professor Alfred Stansfield, of McGill University, investigated the deposits in British Columbia four years ago, and reported as to their amenability to smelting. Now we hear that a committee has been appointed by the Ontario Minister of Mines to investigate the possibilities of Ontario deposits. Among the members of this committee are Professors H. A. Guess and H. E. T. Haultain, of the University of Toronto. A perusal of the Report on British American iron ore resources issued by the Imperial Mineral Resources Bureau leaves a gloomy feeling, and arouses something in the nature of commiseration with this new committee with regard to the unattractiveness of the duties which they have undertaken. The only deposit of undoubted value ever discovered in Ontario was that at the Helen mine, near Lake Superior, where brown hematite was worked for some years prior to 1918. Altogether $2\frac{1}{4}$ million tons was raised and smelted, but in the year named the deposit was exhausted, and the smelting company now depends on ore imported from Minnesota on the other side of the Lake. There is a large amount of siderite left in the mine, but this will not be worked while oxide ores can be readily purchased. Other deposits of siderite in the Province, however, are being worked on a small scale. Magnetite is found in many parts of Ontario, but few deposits are worth considering. One of these is on the Atikokan Range, where lenses of magnetite and pyrrhotite outcrop along the Atikokan River. Owing, however, to the difficulty of removing the pyrrhotite, the ore would not be readily acceptable to smelters, and it is too soon to talk of the electrolytic production of iron from pyrrhotite by the Eustis-Estelle process, though this process is being tested at Trail, British Columbia. Another deposit is in the Mattawin Range, where a banded formation of silica and magnetite, with some hematite, has been prospected ; unfortunately the silica content is too high for direct smelting. At Moose Mountain, near Sudbury, there is a deposit of siliceous magnetite estimated to contain 100,000,000 tons, but the ore would require fine grinding, magnetic concentration, and nodulizing, and at the present time this would not be a commercial proposition. The Report before-mentioned contains a mass of detail relating to numerous other iron ore deposits in Ontario, none of them attractive commercially. There is no reason, however, for saying that no suitable iron deposit will ever be found in Ontario ; on the contrary, scientific prospecting in some of the less known districts might be encouraged.

In the Province of Quebec many deposits of magnetite have been discovered, and they are mostly highly siliceous, or are mixed with ilmenite or sulphides. Of these deposits, the Bristol mine in Pontiac county, the Forsyth mine in Ottawa county, and the St. Charles mine in the Lake St. John area are deserving of mention. The deposits are found in the form of pockets and lenses rather than in beds or lodes, and the ore as a rule passes gradually into the country rock. Until forty years or so ago iron used to be smelted locally in small quantities from bog iron ores, particularly at Three Rivers in the St. Maurice district. These ores are widely distributed, but are not sufficiently plentiful for work on anything like a large scale.

Nova Scotia has been the scene of iron-mining operations in past years. The deposits in the Nictaux-Torbrook area may still be reckoned as of some future value ; these consist of hematite and magnetite, and are of Silurian age. The deposits in the Arisaig district are also said to be worth watching. In the adjoining Province of New Brunswick, the deposit of siliceous magnetite at the Bathurst mine is extensive, and may be workable under different economic conditions. In this province, as in Quebec and Nova Scotia, smelting was conducted on a small scale in the earlier days.

In British Columbia there are many iron deposits which might be worked successfully if there were a more promising outlook for the disposal of products, though it can hardly be said that the quantity and quality of the available ores warrant an active campaign for the stimulation of demand. There has been much mining activity on Texada Island, and at three mines ore reserves totalling five million tons have been proved. The ore is magnetite, occurring in lenses in porphyrite

and limestone, and in some parts is associated with small proportions of iron and copper pyrites. In the Kamloops district, a deposit of high-grade magnetite at Glen mine has been worked on a small scale for some years, and it is believed that large reserves could be developed. Another group of deposits of importance are the limonites of Taseko Valley in the Clinton district. The extent of these beds is not fully known, and the estimates differ in many ways, but Mr. W. M. Brewer gives 22,000,000 tons as fully and partly developed ore averaging more than 40% iron, and 50,000,000 tons as probable ore of the same tenor.

During the last few months we have given considerable space to the iron ore reserves of the British Empire. The reports of the Imperial Mineral Resources Bureau contain much information also relative to the deposits in other countries. On a subsequent occasion we intend to refer briefly to these other deposits.

The Prince and the Mining Men

The dinner of the Institution of Mining Engineers and the Institution of Mining and Metallurgy held at the Guildhall on November 16 was a function of unusual importance to mining men in their corporate capacity. In fact it is not too much to say that it marks an epoch in the public recognition of these two institutions and the work done by their members. In the first place the dinner was graced by the presence of the Prince of Wales ; secondly, it was held at the Guildhall, with the Lord Mayor and Sheriffs of London as guests ; thirdly, there were also present the Home Secretary, the Secretary for Mines, and other Ministers, past and present, many High Commissioners for the Dominions, the American Ambassador, the Dean of St. Paul's, and the presidents and secretaries of kindred societies, including those of the Royal Society and the Institution of Civil Engineers. The explanation of this perhaps almost sudden accession of the two institutions to full recognition is provided undoubtedly by their recent decision to co-operate, to come under one secretariat, and to share a new domicile. It is true that the two institutions have different fields of activity and influence, the Institution of Mining Engineers being concerned primarily with the iron and coal industries of this country, and the Institution of Mining and Metallurgy with the mining of non-ferrous minerals and of non-metallic minerals, but the main object of both is to consolidate and define the rights and privileges of the mining engineering profession, and thus in all except matters of detail they should act in unison. On many occasions before this alliance, or coalition, was effected mining was sometimes not adequately represented in movements requiring the co-operation of engineering and scientific societies. This was owing to the difficulty of deciding which of the two institutions really represented the mining profession, for it was obviously impossible to give representation to both institutions, and unfortunately the difficulty was solved by sending an invitation to neither. It need hardly be said that many efforts were made from time to time to effect some consolidation of the two institutions, but schemes for complete amalgamation or absorption were never acceptable, and it was only when certain leaders of the Institution of Mining Engineers, of whom Sir John Cadman deserves particular mention, evolved the suggestion that Mr. C. McDermid, the secretary of the Institution of Mining and Metallurgy, should become secretary of both institutions that any practical step toward co-operation was taken. At the time this suggestion was made, it happened that the Institution of Mining and Metallurgy was having to seek a new home, so that the proposal became more than a mere personal one. The proposal was not by any means accepted unanimously by many members of the Institution of Mining Engineers, but after its formal acceptance, and with experience of the working of the scheme in practice, many of the former objectors have publicly expressed conversion to the new order of things. If any one still doubted the wisdom of the step, the overwhelming success of the dinner last month must have finally convinced him of his former error of judgment. It is convenient here to add that the scheme of co-operation has been developed much further than was originally contemplated, and that it is by no means confined to the possession of a common secretariat and home. There is now a joint advisory committee, consisting of the presidents of the two institutions and one or two more members of the councils, who discuss all questions affecting the two institutions, and arrive at some general agreed line of policy before submitting the questions to the two institutions independently. This arrangement has been found to work satisfactorily to the advantage of both institutions.

As we have said, the dinner was held at the Guildhall, with the Prince of Wales as guest of honour. Sir John Cadman, president of the Institution of Mining Engineers, was in the chair, and he was supported by Mr. S. J. Speak, president of the Institution of Mining and Metallurgy. In proposing the toast of His Royal Highness, Sir John told his audience the story, which Englishmen are never tired of hearing, of the Prince's kindly and unassuming nature, and of his successful endeavours in working for the good of all parts of the Empire and of all classes. He also informed his hearers that steps were being taken to form an Empire Council of Mining and Metallurgical Engineers, in association with mining societies in Australia, Canada, Africa, India, and elsewhere, and that he hoped eventually that the American societies would join this movement so that there could be an English-speaking Union of Mining Engineers. One of the great advantages of such a Council or Union would be that it would provide the opportunity for defining the qualifications of a mining engineer and for preparing a register of qualified men. It happens that similar action is being taken by the Institution of Civil Engineers in order to ascertain who is qualified to use the term "engineer," and in some ways the mining societies and the Civils do not see eye to eye in this matter. The existence of a Council or Union such as is proposed would greatly strengthen the mining societies in their claim for independent action.

The Prince of Wales, in replying to the toast, made a speech full of sound common-sense, spiced with many flashes of humour. He coupled sea-faring with mining, in that they are both the mainsprings of English prosperity and both subject to an element of danger. On the one hand, he said, those at home should do their utmost for the safety of the sailors and the miners, while on the other hand the sailors and the miners, being brave men, flouted danger on all occasions. He, just home from an accident in the hunting field, quoted the Australian writer who said: "No game was ever yet worth a rap, into which no accident, no mishap, could possibly find its way." The Prince has an intimate acquaintance with mining, for, as Duke of Cornwall, he has many interests in West Country mining. Moreover, in his travels through Great Britain and the Empire he has been down many coal and other mines, and he confessed it was easier for him to talk to the worker underground than to address a gathering of mining experts in the Guildhall. Many other kind things he had to say about mining, and when he sat down it was a pleasure to see how whole-heartedly the old and experienced men of the city and of technology applauded the smiling and fresh-complexioned Prince.

The next item on the programme was the presentation of the gold medal of the Institution of Mining and Metallurgy to Sir Alfred Keogh on his retirement from the rectorship of the Imperial College of Science and Technology. Mr. S. J. Speak gave a suitable address, expounding Sir Alfred's many services in the cause of education, and the medal was handed to Sir Alfred by the Prince. The medal of the Institution of Mining Engineers was presented by the Prince to Sir George Beilby, and Sir John Cadman gave an outline of the recipient's services in connection with fuel problems, in recognition of which the medal was awarded.

Many other speeches were made during the evening in proposing or acknowledging toasts. Mr. W. C. Bridgeman, the new Home Secretary, was cheered, because all mining men recognize his good work as Secretary for Mines in the late Government, and Colonel G. R. Lane Fox, his successor as Secretary for Mines, was given an encouraging welcome. Other speeches were made by Viscount Chelmsford, Viscount Long of Wraxall, Sir Charles Sherrington, President of the Royal Society, and Viscount Cowdray. It is not necessary here to quote these speeches, but we should like to draw attention to some remarks by Viscount Cowdray. He spoke appreciatingly of the work of the Institution of Petroleum Technologists, and he also recommended the two institutions responsible for the dinner to absorb other institutions interested in mining and so add to the strength and influence of the mining fraternity. We take this as a hint that the Institution of Petroleum Technologists might well be under the same control as the Institution of Mining Engineers and the Institution of Mining and Metallurgy. This view was voiced by us eighteen months ago, and we are glad to believe that Lord Cowdray's influence will be exercised in this direction. We may suitably conclude this article by repeating our opening remark that this dinner marks the opening of a new era for the professional societies identified with mining operations.

REVIEW OF MINING

Introduction.—The return of the Conservative party to power under promise to conduct the government of the country on more business-like lines is a good augury for the future, and a general improvement in trade conditions may be expected. The outputs of coal and iron in this country are slowly increasing. The advance in the price of tin recorded last month has not been entirely maintained, but there is rather less speculative movement now, and the present price is more reflective of consuming demand. Lead and zinc prices are high for immediate requirements. More lead is expected from Mexico in the near future. An attempt to raise the price of copper in sympathy with other non-ferrous metals failed, owing to the large amounts available.

Transvaal.—The relative importance of South African investments in the business of the Consolidated Gold Fields of South Africa becomes less every year. Of the three gold mining companies on the Rand under its control, Robinson Deep is now the most interesting, and substantial profits are being earned. Simmer and Jack is near its end, but operations may be continued for some time on ground acquired from Simmer Deep. Of American holdings those in the American Trona, South American Gold and Platinum, and South American Copper are the most important. At the property of the first-named, the refining plant was reopened in April, following a revival in the demand for potash and borax. The output during 1921 at the properties of the South American Gold and Platinum Co., in Colombia, was 14,327 oz. platinum and 4,462 oz. gold, and was valued at $972,000 ; it is announced that the third dredge is ready to start. The new smelter of the South American Copper Syndicate, operating in Venezuela, is expected to commence operations before the end of the current year. The Gold Fields has also gone in for oil, and has a controlling holding in the Goldelline Oil Corporation, a company which holds leases in Texas, Oklahoma, and elsewhere. The yearly report and Lord Harris's speech to shareholders review the business of the Gold Fields with the customary detail. An event of the year that will undoubtedly have considerable influence on the future policy of the company is the election to the board of Mr. J. A. Agnew.

Announcement is made that the Union Corporation has made an arrangement with Minerals Separation for the erection of a flotation plant at Modder Deep for the treatment of sand before it goes to the cyanide vats. The proposal is to re-grind the pyritic concentrate thus obtained and send it to the slime-treatment plant. This scheme, it will be seen, is a variant of the all-sliming process now in the ascendant, the difference being that only the pyritic content of the coarse material will be slimed, the coarse siliceous matter being treated without further comminution. An increase in the recovery of the gold will thus be obtained at a less cost for crushing.

Rhodesia.—The output of gold during October is reported at 54,670 oz., as compared with 55,443 oz. in September and 53,424 oz. in October, 1921. Other outputs reported for Southern Rhodesia for October were :—Silver, 14,433 oz. ; coal, 47,089 tons ; copper, 287 tons ; asbestos, 1,668 tons ; arsenic, 24 tons ; mica, 7 tons ; diamonds, 27 carats.

The report of the Gold Fields Rhodesian Development Co. for the year ended May 31 indicates that in the opinion of the directors chances for any substantial expansion of operations in Rhodesia are not very good. With the exception of the Shamva, the mines controlled by the company are not developing in an encouraging manner. In particular the Falcon and Planet-Arcturus are disappointing. The company has taken an increased interest in Rhodesian and General Asbestos. Owing to the absence of opportunities in Rhodesia, the company has purchased 100,000 shares of $5 each in the South American Gold and Platinum Co., an American company mentioned in a preceding paragraph dealing with Consolidated Gold Fields. Many shareholders expressed surprise that this latter investment should be made, but it may be taken as evidence of the tendency of the Gold Fields group to leave South Africa.

At the meeting of the Wankie Colliery Co., Mr. Edmund Davis gave some reminiscences of the arguments between the Rhodesia Chamber of Mines and the company with regard to cost of coal and a proposed increased output. The Chamber of Mines had urged that with a larger output lower prices and increased demand would accrue, and the company accordingly acceded to the Chamber's request to open up a new colliery. The increased business has, however, not arrived ; in fact, the coal sales have not increased during the last two

years. Moreover, the average price at pit's mouth during 1921, 11s. 5d. per ton, cannot be considered burdensome. Mr. Davis is of opinion that the Chamber should lay the blame for adverse conditions, not on the management of the mine, but on the high charges and inefficient service of the railways. It is worth recording that the company has recently made an eight years' contract to supply the Union Minière du Haut Katanga with 5,000 tons of coal and 8,000 tons of coke per month.

Portuguese East Africa. — At a meeting of the Mozambique Oil and Mineral Concessions, Ltd., Captain Lionel Cohen, the managing director, gave a long account of his travels and of his discovery of alluvial gold deposits along the Nahavarra and Namirrue rivers, in the Muguvollas and Quilimane districts respectively. If his statements are confirmed by an alluvial mining engineer, the discovery will prove to be of importance. But Captain Cohen is not a mining engineer himself, and his method of testing and reporting would not satisfy an expert in these matters. In particular, objection may be taken to his policy of sending samples of the ground to London for assay by a firm of metallurgists. This is not the way to test the content of alluvials, and Messrs. Sulman and Picard, the metallurgists in question, rightly object to the use of their name in the manner indicated.

Australia.—The Mount Lyell company has cabled a summary of the results for the year ended September 30. During this period the smelter treated 36,820 tons of Mount Lyell ore, 20,196 tons of North Lyell ore, and 23,495 tons of concentrates. The yield of blister copper was 6,066 tons, containing 6,019 tons of copper, 137,392 oz. of silver, and 2,761 oz. of gold. The reduced production of silver and gold is due to the decline in the amount of Mount Lyell pyrites smelted, following the change in policy outlined in the MAGAZINE for March last, according to which only concentrated North Lyell ore is to be smelted in future, instead of a mixture of raw Mount Lyell and North Lyell ores. Further concentration and sintering plant is being erected in pursuance of this policy, and the reorganization should be completed by the end of February. By means of this new policy the output of copper is maintained, with a very much smaller staff of employees. The company also reports that the labour position is much more satisfactory than in October, when we reported a deadlock over the Court award. The Court had awarded in favour of the company in the matter of wages and hours, and the men had threatened to refuse the terms. It is now reported that the men are working under the award.

The Zinc Corporation announced on November 15 that, owing to the approaching exhaustion of the old dumps, it would be necessary to reduce the shifts on the zinc concentration plant from three to two per day. This announcement was followed by another on November 27 to the effect that work would be further reduced to only one shift per day. It was also announced that, in order to keep the organization together, the mine is to be reopened for a trial period of six months. It is hoped that during this period some modification may be made in the wages and labour conditions known as the "Edmunds award." The corporation's mine contains ore of lower grade than is found at most of the mines at Broken Hill, and labour costs have to be watched closely.

The Sons of Gwalia reports that a 25-stamp mill is to be erected, and that a policy of selective mining is to be adopted. It will be remembered that the plant containing 50 stamps was destroyed by fire in January, 1921, and that at present work is confined to the re-treatment of old sand and slime by cyanide.

The Mount Boppy mine was closed a year ago, and the other property in the same district on which the company took an option has proved unsuitable and the option has been dropped. Subsequently the company acquired an option on a newly discovered property near Wellington, New South Wales, and with Government financial assistance a shaft is being sunk and some development done. The company has also acquired a claim at Muriel Tank, where gold lodes were discovered recently, but the results so far are not particularly encouraging, and active prospecting has been suspended for the time being.

Malaya.—The Government of the Federated Malay States has made an official announcement that the stocks of tin acquired during the period of depression will not be released until it appears desirable to sell. When tin reaches a certain price, which is not stated, small quantities will be released weekly. If the price falls off again below the point fixed no further tin will be released until prices revive. This announcement, it will be seen, is studiously vague, but it may

be presumably interpreted as meaning that no stocks are being realized at present and, therefore, as being intended to contradict the rumours lately prevalent. It also means that nothing will be done to disturb the market.

Mexico.—The Mexican Corporation reports that during the year ended June 30 last 635,959 tons of surface ore averaging 0·14 dwt. gold and 5·75 oz. silver per ton was treated at the Fresnillo mine, Zacatecas, and that the yield was 3,798 oz. gold and 2,943,466 oz. silver. The silver was sold at an average price of 65½ cents, and the cost of mining and milling was well under the original estimate of $1·92 per ton. The operating profit was $523,098, of which $318,300 accrued to the Mexican Corporation. This profit is being used locally, and no distributable funds have yet been remitted to this side. The first unit of the new cyanide plant, having a daily capacity of 2,000 tons, commenced operation on August 1, 1922, and was working at full capacity at the end of December. Shortly afterward additional plant was installed, bringing the daily capacity to 2,500 tons. It has since been decided to further increase the plant to a capacity of 95,000 tons per month. The reserves at the surface deposit are estimated at 3,329,000 tons, averaging 5·14 oz. silver, and 1,978,000 tons, averaging 3·65 oz. Exploration of the deposit in depth has been continued, and on the old level known as the Providencia an ore-shoot has been defined 1,650 ft. long, 20 to 50 ft. wide, and averaging as far as sampled 11 oz. silver per ton.

Colombia.—At the meeting of the Colombian Corporation it was announced that the building of a treatment plant for the Constancia gold mine is still being postponed until the Bocas road is built. Owing to the capital of the company not being sufficient for the completion of the road and the erection of the mill, it has been decided that the parent company, Oroville Dredging, shall bear the expense of the road and acquire the concession for its building. As the latter company has already undertaken the river transport and has built the necessary steamers, the transfer to it of the road transport problem seems appropriate. As regards the mill, the present design provides for a capacity of 300 tons. Mr. W. A. Prichard, however, reports that the reserves are such as to warrant a 600-ton or even 1,000-ton mill, and he is anxious that the mining as well as the milling outfit should be re-designed on the larger scale.

Trinidad.—The Apex (Trinidad) Oilfields has arrived early at a dividend-paying stage, the announcement of a 10% distribution being made last month. This company was formed in August, 1919, and its drilling campaign has been uniformly successful. The only mishap was the loss of oil at No. 3 well owing to the initial flow being far greater than expected. At the present time the output is limited to 10,000 tons per month, as the Trinidad Leaseholds, which buys it for refining, cannot take any more. An outlet is being sought elsewhere for additional production.

Persia.—The Anglo-Persian Oil Co. reports a profit of £3,130,380 for the year ended March 31 last, after allowing for depreciation and debenture interest. An additional £400,000 for depreciation is written off this profit, and £600,000 is placed to reserve. The sum of £480,000 is distributed as dividend on the first preference shares, and £315,000 on the second preference, while the ordinary shareholders receive £1,245,000, being at the rate of 20%, less income tax. It is expected that the extensions to the refineries in Persia and South Wales will be completed in June next, when the output of marketable products will be largely increased.

Roumania.—Arrangements have been made for the amalgamation of the Roumanian Consolidated Oilfields and the Phœnix Oil and Transport Co., which themselves were formed at earlier dates as consolidations of companies interested in the development of oil deposits. It is also announced that the British, French, and Roumanian Governments have at last agreed to the terms of compensation of the first-named company for the destruction of its property preceding the German invasion of 1916.

China.—The Chinese Engineering and Mining Co., operating at Kaiping, North China, reports that the sales of coal by the Kailan Mining Administration during the year to June 30 last were 3,536,027 tons, a reduction of 239,352 tons as compared with the previous year. This fall was due to the disturbed political condition and the military operations in the Chi-li province during March and April. The company's profit for the year was £354,686, of which £176,543 has to be paid as income tax and corporation profits tax. The shareholders receive £189,000, the rate being 13½% tax paid, as compared with a distribution of 22% tax paid the previous year.

CONCENTRATION AT BROKEN HILL SOUTH

By V. F. STANLEY LOW, M.Inst.M.M.

The Author reviews a paper presented by W. E. Wainwright and T. A. Read to the Australasian Institute of Mining and Metallurgy.

INTRODUCTION.—Series No. 44 of the *Proceedings* of the Australian Institute of Mining and Metallurgy, recently to hand, contains an interesting paper of 69 pages by Messrs. W. E. Wainwright and T. A. Read on the concentration practice at the plant of the Broken Hill South Company, Broken Hill, New South Wales. The paper is a voluminous one, and is illustrated by 26 sheets of diagrams. Unfortunately, the printing of these diagrams is so poor that the details of many of them are undecipherable, and the work reflects small credit on the Institute's printer and pays but little compliment to the authors of the paper.

It may be well to say preliminarily that Messrs. Wainwright and Cunningham presented a paper to the Institute a short time previously to the present paper in question entitled " Description of New Plant at South Mine, Broken Hill." It should be said that the earlier paper dealt chiefly with the new power plant erected after the fire, and that the later paper is in the nature of a comprehensive survey of the concentration work done at the mine since the beginning. The later paper, however, adverted also to alterations in the concentration plant after the fire ; and here arises some confusion of detail in the subject matter of the two papers in question. For instance, Cunningham and Wainwright state that each of two ore-breaking units will have one 30 by 18 jaw breaker and two subsidiary gyratory crushers, while Wainwright and Read describe a plant in which 3 gyratory crushers and one jaw crusher are used, the jaw crusher running 5% and the gyratory crushers 60% of the full mill time. Further, Cunningham and Wainwright state that the trommelled material from the rolls passes through a drag classifier before delivery to the jigs, while Wainwright and Read state that the trommelled ore is passed over King revolving screens before reaching the jigs. Again, Cunningham and Wainwright state that trommels and jig bottoms have 4 mm. openings, while Wainwright and Read give 3 mm. as the size of trommel perforation. Finally, Cunningham and Wainwright state that in the re-grinding department sections 2 and 4 are fitted with grinding pans and sections 1 and 3 are fitted each with a No. 64½ Marcy mill. On the other hand, Wainwright and Read describe the re-grinding department as having grinding pans in three of the sections and a Krupp tube-mill in the fourth. However, turning to page 233 of Series No. 44, it would appear that Wainwright and Read have described the mill as it stood until July, 1919, when part of it was destroyed by fire ; and one judges that the differences in design, as described by Wainwright and Cunningham in the earlier paper, refer to the reconstructed plant as it is to-day. Therefore, one must bear in mind these modifications when reading the paper now under review.

At the present time the South mill produces only lead concentrates in the table plant and in the slime flotation plant. The coarse zinc tailing goes to the Amalgamated Zinc (De Bavay) companny for treatment, and will do so until the end of 1923, and the zinc tailing from the slime flotation plant is being stacked because a slime zinc concentrate is not at present a desired commercial product.

In their paper Wainwright and Read state that the milling described is typical for the recovery of galena in the form of concentrate from Broken Hill ores, the main difference from the other mills being the substitution by the latter of tube-mills for grinding pans when grinding jig tailing prior to table treatment. This, of course, must be regarded as only a very broad statement of the case. An intimate study of the various mills will show the existence of considerable differences in detail, differences due to the varying nature of the ores treated in the various mills, and to the fact that milling has ever been a progressive science in Broken Hill, each new mill embodying alterations due to experience gained on the field as a whole ; for, as far as gravity concentration has been concerned, each manager has made his methods an open book to his inquiring brother, and each has given to the other as freely as he, himself, has sought.

THE SOUTH MINE ORE.—The ore in the South mine is of two classes—siliceous and

calcitic—as will be seen from the following analysis :—

	Siliceous.	*Calcitic.*
Insoluble (SiO_2, etc.)	37·71	30·12
Pb	15·50	13·40
Cu	0·10	0·20
As	0·18	0·43
Sb	0·03	0·06
Fe	4·90	3·03
Al_2O_3	2·40	1·25
Mn	2·47	1·70
CaO	4·00	15·70
Zn	17·00	12·60
S	13·80	9·70
CO_2	1·30	11·60
F	0·24	0·078
Oz. of Ag per ton	11·7	3·2

It will be observed that the siliceous ore carries considerably more lead, silver, and zinc than the calcitic.

Calcitic ore is peculiar to the northern and southern ends of the Broken Hill ore-body, while the siliceous is, to a great extent, representative of the ores of the intervening mines where the presence of rhodonite makes the crushing of the ore more expensive, renders gravity concentration more difficult, and increases the sliming of the galena contents during reduction. On the other hand, the amount of calcite in large bodies of the South ore renders treatment by sulphuric acid processes such as the Delprat —which is so successful at the Proprietary mine—far too costly to be practicable.

EARLY HISTORY AT SOUTH MINE.—The history of the South mine shows that development work was started there in 1885. Such oxidized ore as was then raised was sold to other companies near at hand who were already carrying on smelting operations. The Broken Hill Proprietary started smelting in 1886. Smelters were erected by the South company in 1891 and were in blast until the high-grade oxidized ore gave out two years later. In 1888 a few concentration experiments were made with a Cornish hand jig. In 1893 the South Company sent a parcel of ore for trial at Moonta, where plants for the concentration of copper ores were already in successful operation. The results from this trial were so satisfactory that in 1894 the company erected its first concentration plant, so that in that year both the South Company and the Block Ten Company had concentration plants in operation. The South Company's plant dealt with the friable sulphides found in the upper level, and consisted of a 12 by 7 jaw crusher, 27 by 15 Cornish rolls, trommels, hydraulic classifier, and two Hancock jigs. The feed to this mill assayed 36% Pb, 5 oz. Ag, 18·5% Zn, and the concentrate produced assayed 71% Pb, 9·2 oz. Ag, 6·7% Zn. Two more Hancock jigs were added in 1895. In the same year four Cornish circular revolving tables were installed for treating the overflow from the hydraulic classifier. In 1896 a 15 by 9 jaw cracker was added to the plant; and in 1897 six more Cornish round tables were installed. The revolving tables are erroneously called "buddles" in the history set down in Wainwright and Read's paper. In 1900 five Wilfley tables displaced the round tables and trials were made with May Brothers' jigs. In 1901 gyratory displaced jaw crackers and more rolls were added. In this year eight Heberle vertical disc grinders were installed for grinding the tail from the Hancock jigs; and the ground tail was treated on four May jigs; the number of Wilfley tables was increased to twelve; and six Luhrig vanners were used for treating slime. The plant now had a capacity of 3,000 tons of ore per week, and at the end of 1904 the ore reserves in the mine were estimated at 1,300,000 tons. Early in 1905 it was decided to construct a new mill and, in the meantime, experimental work was carried on with various appliances. Krupp ball-mills replaced the disc grinders; the Krupp ball-mills were in turn superseded by grinding pans; and in 1906 a 14 ft. by 4 ft. 7 in. tube-mill replaced several of the grinding pans. In 1907 Wilfley tables were used instead of jigs for treating the re-ground tail from the first, or coarse, jigs. At the end of 1905 these experiments were considered sufficiently advanced to allow of the preparation of designs for a new gravity mill capable of dealing with 6,000 tons a week. The erection of this plant was completed in May, 1908.

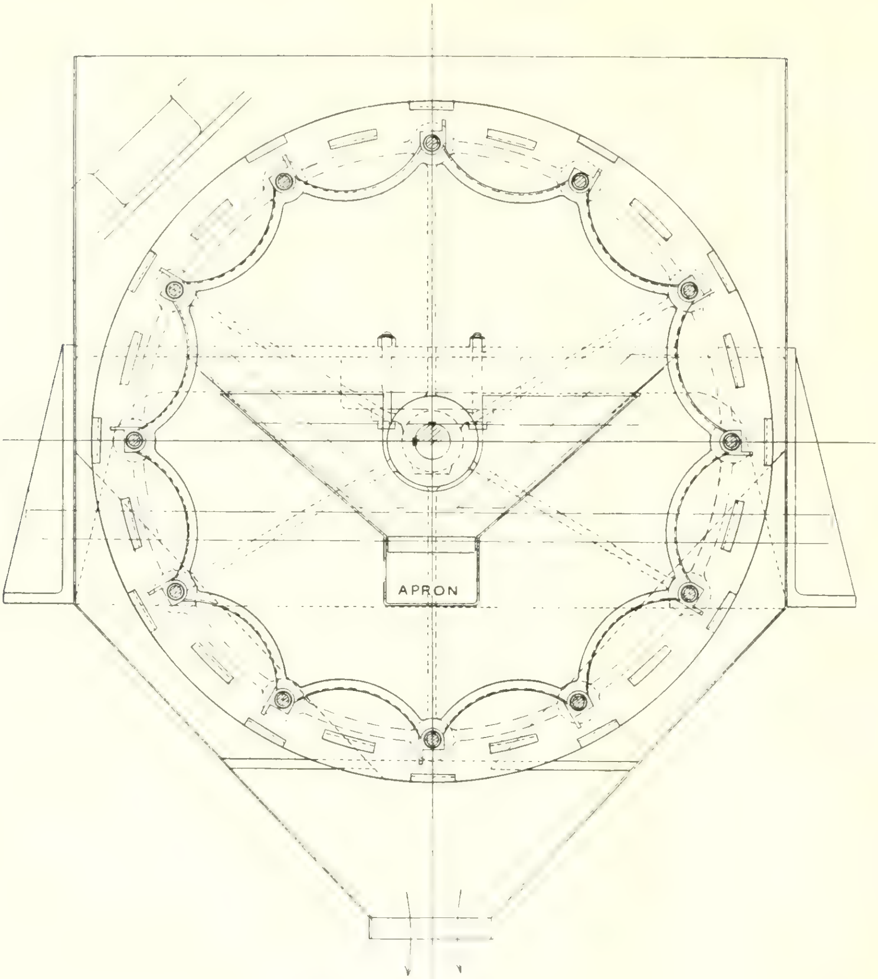
Such is the history of the mine till the middle of 1908. Meanwhile other companies on the field had been experimenting and building. It is possible to pick up a little history here and there of the different companies and their mill construction; but, as far as I am aware, no chronological history embodying the work of all the metallurgists and of the construction and operation of their mills has yet been written. If such a history were compiled the name of John Warren, for 12 years general manager of the Block Ten Company, would stand out pre-eminently as a pioneer in the concentration of the Barrier ores; but so modest was he that in his presidential address to the Australian Institute of Mining Engineers

in 1902 he simply alluded to the fact that the first concentrate from Broken Hill ores was despatched in May, 1893, and assayed 38·6 oz. Ag, 70% Pb, and 6·25% Zn. From the high silver content of this concentrate it may be taken for granted that the crude ore used in the making came from and was concentrated on the Block Ten mine by John Warren. A belt vanner patented by him and which embodies the good qualities of both the Luhrig and Triumph vanners was for many years in successful use in Broken Hill and other Australian mining centres. The Warren vanner had lateral slope, longitudinal travel, adjustable speed, and end shake with eccentric motion. It was eventually displaced by the Wilfley table, the first of which was introduced into Broken Hill by the Broken Hill Proprietary in 1898. Following John Warren's work that of the Broken Hill Proprietary was regarded for many years as being the most progressive in gravity concentration; and the large mill put into operation by that company about 1900 embodied the latest practice in ore-dressing at that period.

Reverting to the paper by Wainwright and Read, the mill of 1908 was constructed so as to include four independent sections, each having a capacity of 250 tons in 24 hours. The ore from the mine was tipped into one of four bins from which it gravitated to either one of three No. 5 Gates gyratory crushers or to a Hadfield 30 by 18 jaw crusher by means of which the ore was reduced to 2 in. gauge. The crushers discharged the 2 in. ore into bins from which it was carried to the mill storage bins by an 18 in. conveyor; and on the way the ore passed through the sampling plant. The ore from the mill storage bins was delivered by roller feeder over a shaking screen with 4 mm. openings to 36 by 18 rolls, from which it passed to trommels, the undersize from which was delivered to May jigs. The oversize from the trommels was returned to the same set of rolls through which it had previously passed. The concentrate from the jigs passed to bins for despatch; the tail was ground in pans and sent to the Wilfley-table section for treatment. The Wilfleys produced a lead concentrate which went to the despatch bins, a zinc tail which was delivered to storage dumps, and a lead tail which was sent to the underground workings for stope-filling purposes. The slime produced in the milling plant was thickened and treated on Luhrig vanners, the concentrate therefrom going to despatch bins and the tail to slime dumps.

Experience in the Barrier mills has shown that, except for the elimination of slime, the most satisfactory method of jigging the Broken Hill ores is without previous classification. The washing out of the slime was generally performed in an inverted cone, or other similar appliance, supplied with a rising stream of clear water into which the crushed ore was fed at the head of the jig; but in the South mill, in order to raise the jig concentrate to as high a grade as possible prior to its despatch to Germany, this class of slime eliminator was replaced by revolving King screens covered with 30-mesh woven brass cloth. Only the oversize from the screens passed to the jigs; the through size was sent to the tabling department.

The King Screen.—The King screen, as described and illustrated in the paper, has proved to be one of the most efficient appliances for removing the fine meal and slime from the crushed ore; but my experience of the screen has been that upkeep has been costly on account of the rapid wear of the woven wire; and no information is given in the paper as to its life when used at the jig-head. As the material to be treated is fed on to the outside of the screen it is necessary to have the delivery end of the screen entirely open, except for the shaft, to allow of the placing in the interior of the appliance the apron upon which the through size falls and by which it and the accompanying water are discharged. This requires that the whole weight of the screen and of the load of material carried thereon must be supported from the solid end of the screen. Therefore the solid end is cast with a heavy boss and is strengthened with webs. In the earlier types of King screen the solid end was not made sufficiently strong; and delays were caused by fracture of the cast iron. The open end of the screen consists of a cast-iron ring connected with and supported from the solid end by 12 bolts, each passing through a length of piping which acts as a distance piece between the ring and the solid end. On the inside of both ring and solid end lugs and ledges stand out, the latter forming the seat for the woven screen which is kept in place by wooden blocks wedged between them and the former. By this means the screen takes the form of twelve longitudinal troughs, the edges of which are formed by the distance piping through which the longitudinal bolts pass. The driving shaft, which passes



CROSS SECTION OF KING SCREEN.

through the screen, and to which the solid end is keyed, is 5 ft. $10\frac{1}{2}$ in. long and $2\frac{1}{2}$ in. in diameter; the width of the screen is 3 ft.; and the overall diameter of ring and solid end is 3 ft. $9\frac{1}{2}$ in. Wash-water pipes play on both inside and outside of the screen. The screen makes 8 r.p.m. and is enclosed in a splash-proof box.

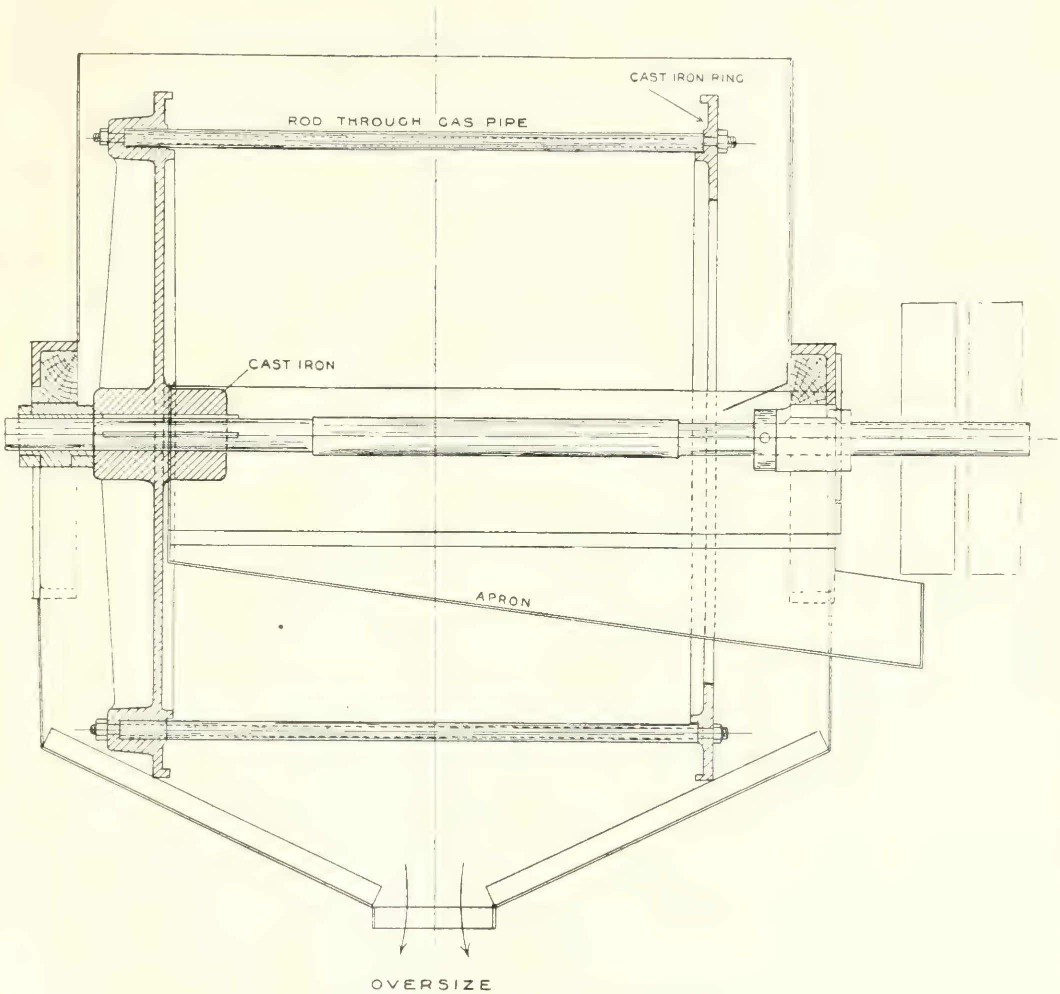
The work performed by the King screens at the jig heads in the South concentration plant may be seen from the following table :—

[illegible]	Aperture mm.	Feed to screens. % weight.	Oversize. % weight.	Through size. % weight.
+ 10	1·27	12	18	—
20	0·635	16	30·5	—
40	0·317	12	19	9
60	0·211	9	7·5	14
80	0·177	5·5	4·5	11
100	[illegible]	11·2	5	21·5
150	0·084	10·3	4	12
— 150	0·084	14	11·5	32·5

LATER HISTORY.—In 1909 the South Broken Hill company entered into a contract with the De Bavay company for the treatment by the latter of the zinciferous tail from the former's mill. This necessitated the finer grinding of the tail; therefore the re-grinding plant was put into close circuit with revolving screens of 16-mesh. The output from the mill then became :—

	Weight. %	Lead. %	Silver. Oz.	Zinc. %
Crude ore	100	14·9	6·1	12·7
Concentrate	15·3	71·7	21	5·3
Zinc tail	44·3	4·1	3·6	18·2
Quartz tail......	27·3	2·3	1·8	8·3
Slime	13·1	11	5·6	11·6

In 1911 the concentration plant was again altered by the elimination of the Luhrig vanners; the installation of more tables, and the introduction of 20-mesh screens over which the quartz tail passed, the through



Longitudinal Section of King Screen.

size from which, together with the thickened slime from the plant, was passed over tables. In 1916 the flotation plant for treating slime was put into operation.

The 1918 Flow-Sheet.—The sequence of treatment as practised until part of the plant was destroyed by fire in July, 1919, is given in the accompanying flow-sheet.

Hoisting and Crushing Methods.—In all cases except one the ore is raised from the Broken Hill mines in single-deck cages carrying either one or two trucks. Skips are in use at the South Blocks mine. Not only is the truck system more flexible where so many levels are worked, but it overcomes one of the major difficulties in breaking ore on contract, the calculation of the moneys due to contractors. In the earlier days, when wage calculations were based on stope surveys, there was endless trouble with dissatisfied contractors. Under agreement with the workers the ore is weighed as near to the shaft brace as is practicable, in the presence of a check-weighman appointed by the contractors ; but the checker has no power to interfere with the scales or the operation of weighing. To the side of each truck is attached a small metal pocket into which is slipped a card bearing the identification number of the contract party by whom the contained material was broken ; this card is placed in the pocket before the truck is despatched from below. On arrival at the brace the truck is weighed, the ticket removed, and the nett weight credited to the contractors. The trucks are of the doorless,

box type; and on the South mine weigh 6 cwt., and contain approximately one ton of ore. The wheels are fitted with roller bearings.

The arrangements at the South are such that the weighed, full trucks on leaving the brace are run by hand along a set of rails situated at the top of, and along one side of, the first series of ore bins, four in number and of total capacity of 800 tons. Over each bin is placed a tippler of the side-tipping, rotary type. Rail switches are so arranged that the full trucks may be delivered from the full line to any one of the tipplers and, after having been emptied, are passed on to the empty line on the opposite side of the bin top by which they are returned to the shaft.

Owing to the fact that contractors frequently include waste rock with the ore some system of inspection is necessary. At the South mine inspection takes place between the weigh-bridge and the first ore-bin where occasional trucks are tipped into a small bin. The waste is then sorted out, thrown into a bin below, and eventually goes to the waste dump; the ore is re-loaded into a truck, re-weighed, and sent to the crushers.

Forming portion of the bin floor, at the entrance to each outlet door, is a grizzly with $1\frac{1}{2}$ in. openings over which the ore passes as it gravitates to the crushers. Reference has already been made to the layout of the crushers. It is stated in the paper that the station consists of one 30 by 18 Hadfield jaw crusher and three Gates gyratory crushers, and that the jaw crusher is mostly used for crushing ore too large for the gyratory crushers. The three No. 5 Gates crushers run at 390 r.p.m. and take 30 h.p. each; the jaw runs at 250 r.p.m. and requires 50 h.p.

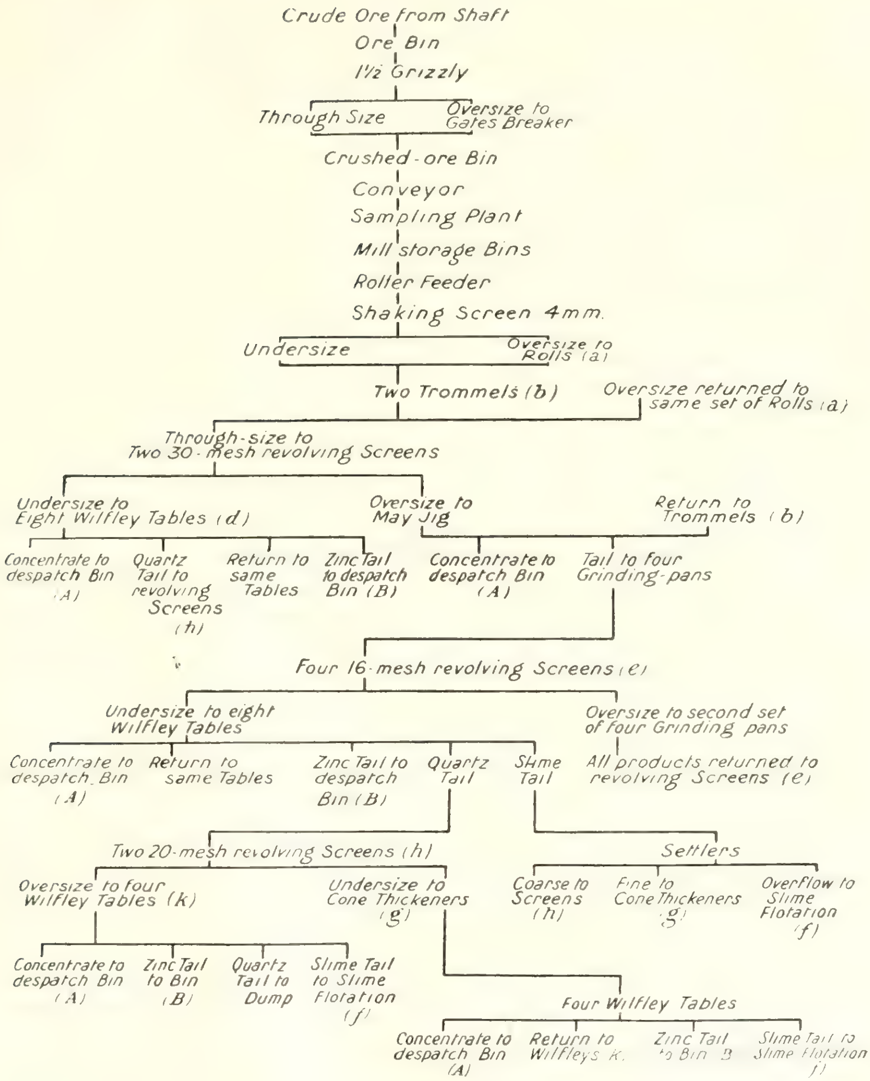
Metallurgists in Broken Hill are not unanimous regarding the relative good qualities of gyratory and jaw crushers. Cunningham and Wainwright in their paper complain that jaw crushers, as usually manufactured, cause loss of time due to heated bearings. To overcome this they re-designed the bearings and fitted their jaw crusher with a flood lubrication arrangement, oil filter, etc. On the Central mine (Sulphide Corporation) in the earlier days jaw crushers used to give trouble by bursting and thereby becoming useless when tramp iron found admission. This was overcome by having the body of the crusher cast in sections and held together by steel bands. Under undue stress the steel bands gave way and thus saved the body of the crusher from actual fracture. In gyratory crushers shafts have been frequently broken or bent by the accumulation of damp, fine material between the crushing parts. My own experience of gyratory crushers working on the very hard rhodonite ores was that the white metal which faced the wearing faces of the eccentric was squeezed out, so that all eccentric motion was lost. As Block Ten was well equipped with a foundry I was able to have all eccentrics made entirely of gun-metal, thereby doing away with the white metal, and re-casting the entire eccentric when this became worn.

In the South mill a bin is placed under each crusher; and the capacity of the whole is 670 tons. These bins receive the fine ore from the grizzlies as well as the crushed ore from the crackers. The crushed ore now having lost height by gravitating through a considerable distance, it becomes necessary to raise it again to the mill storage bins, which have a capacity of 1,100 tons. Here this is done by means of two crossed conveyors, each 210 ft. between centres, 18 in. wide, operating at an angle of 18°, and delivering the ore through a total height of $38\frac{1}{2}$ ft. In the mill of the Broken Hill Proprietary the re-elevation of the crushed ore is performed by hydraulic lifts carrying trucks filled with the crushed material. At the Central and the Block Ten mines, where the concentration plants are at considerable distances from the primary crushing units, the conveyance and re-elevation of the crushed ore are performed by aerial trams.

Sampling.—At the point of crossing the conveyors enter the sampling plant where one-two-hundredth (1-200th) by weight is automatically removed by deflecting the ore stream once in every 70 seconds. The accumulated sample of 24 hours is daily passed through a jaw crusher, which reduces it to 20 mm. maximum size. The crusher sample passes over a Vezin sampler, which removes one-tenth (1-10th) part, giving one-two-thousandth (1-2,000th) of the ore milled. The material saved by the Vezin sampler is reduced to 10 mm. gauge and cut down to 56 lb. by a Jones riffle. All rejected material from the sampling plant is sent back to the conveyor and thence to the concentration plant.

Wainwright and Read state that the following tests were made on sampling the crude ore:—

(1) Hand sampling between the crushed-



THE 1918 FLOW-SHEET.

ore bins and the shaking screens. This method gave erratic results.

(2) Machine sampling of the undersize from the trommels. This method gave results which corresponded closely with those of the crude-oil sampling plant; but tramp chips of wood caused obstruction in the sampler.

(3) Computing the value of the crude ore from the various products, commonly known as "working back." This method is also said to have given results similar to those obtained in the sampling plant.

Very strong opinions are held by Broken Hill metallurgists with regard to sampling methods; and few would agree to the adoption of methods (2) or (3) just quoted. For a company which has a large output automatic sampling, as described in No. 1, would prove of benefit; but there is no reason why, if sufficient care is taken, correct results should not be obtained by hand sampling the crude ore as it issues from the crushed-ore bins. Many of the mines have found such a system trustworthy; and it is an easy matter to check the sampling periodically at but little extra expense. The Broken Hill Proprietary, among others, made extensive checks on the hand sampling, as described in No. 1, and found it reliable.

No. 2 method should be dismissed from consideration, as all ores—especially those

which slime so freely—should be sampled before they come into contact with flowing water, which can be relied upon to remove some of the softer, and richer, material and give a lower value to the crude ore, thereby ensuring a corresponding increase in the computed recovery.

Method No. 3 is never used by metallurgists who do not wish to delude themselves. In the average gravitation mill only two weights are actually taken, those of the crude ore and of the concentrate. A company which sells its by-products will, no doubt, weigh them during despatch; but the despatch may not take place for a considerable time. Generally speaking, the weight of the tailing produced is calculated from the truck tally or conveyor output as the material goes to the dump; then the estimated difference between the weight of the crude ore, on the one side, and that of the concentrate together with the estimated weight of the tail, on the other, is assumed to be the weight of the slime. The figures so obtained may eventually be checked by survey of the by-product dumps; but the results of such checks are so late when received as to be of no particular value so far as the immediate work of the mill is concerned. As the slime is high and the tail comparatively low in mineral content considerable error may be made in "working back" to the crude ore value if the tonnage of slime is under or over estimated. In "working back" too many assumptions have to be made for the system to be reliable in daily work. Assays of the product and by-products can be relied upon; but the case is far different with the weights.

FURTHER COMMINUTION.—The South mill is constructed in four sections, each of 310 tons capacity in 24 hours. The ore in each section is delivered from its bin by a horizontal roller-feeder placed in front of the bin door and travelling at 1·8 r.p.m., Rack-and-pinion doors regulate the amount of ore going to the roller feeder. The ore from each feeder passes to a shaking screen set at an angle of 10°, perforated with 4 mm. round holes, and making 162 strokes per minute. The through size from the shaking screen joins the undersize issuing later from the trommel and with it goes to the King screen placed at the head of the May jig. The oversize from the shaking screen passes to the rolls which crush the ore to 3 mm. gauge. One set of rolls is used in each section. The roll shells are 36 in. in diameter and have a crushing face 18 in. wide. One shell is flanged, the other plain, the plain shell lying within the flanges of the other when the faces are in, or nearly in, contact. The rolls are kept in contact by bolts which pass through rubber buffers and are gear-driven at 16 r.p.m., the gear wheel on the shaft of one roll having one tooth less than that on the shaft of the other in order to prevent corrugation of the faces of the shells. The shells are easily removable, as they are held on coned centres by six tightening bolts. The capacity of each set of rolls is 265 tons of South crude ore through 3 mm. in 24 hours. The crushed ore from the rolls of each section passes through a pair of cylindrical trommels.

It is to be surmised that on account of structural difficulties trommels have been retained in the South mill. By most metallurgists trommels are regarded with disfavour. It is true that those of the South company are gear-driven, instead of having a direct belt-drive, and are therefore not so liable to stoppage through slipping or broken belts when the belt pulleys have become wet or the trommels overloaded; but, when compared with shaking screens, the wear on the perforated covering of trommels is excessive, more wash water is required, there is less accessibility for inspection, cleaning, and repair; and it takes considerably more time to change the screen on a trommel than it does on a shaker. Running time may be saved by having spare trommels ready to replace those requiring repair; but this does not lessen the cost of upkeep. Moreover, extensive trials made in Broken Hill showed the efficiency of shaking screens to be 12% better than that of trommels.

The twin trommels of the South company are 6 ft. long, 2 ft. in diameter, and covered with plate punched to 3 mm. They are set at an angle of 15° and are gear-driven at 32 r.p.m. The life of the punched plate is 14 days.

The oversize (raffs) from the trommels, together with the material from the second hutch of the May jig, is returned to the same set of rolls in which it was formerly crushed. The returning of raffs to the same set of rolls (single-stage crushing) is usually practised in Broken Hill. At the Broken Hill Proprietary mill series crushing was introduced about 22 years ago. There the ore from the gyratory crushers passes over shaking screens to three sets of rolls, 36 by 15, set $\frac{3}{8}$ in. apart, and speeded at 30 r.p.m.

The ore which has passed through these three sets of rolls passes over shaking screens, the undersize from which goes to jigs and the oversize is raised by elevator to the next bin from which it is fed to three further sets of rolls, 36 and 15, set at $\frac{1}{8}$ in. apart, and speeded at 45 r.p.m. The product from the second set of rolls passes over shaking screens, the undersize going to jigs, the oversize being raised by elevator to the third bin, from which it is fed to the third set of three rolls, 36 by 15, set $\frac{1}{16}$ in. apart, and speeded at 78 r.p.m. The material from the third set of rolls passes over shaking screens, the undersize goes to jigs and the oversize to a ball-mill. It is claimed for series crushing that a certain amount of classification takes place automatically, the richer and softer ore being reduced in the first series of rolls, and only the poorest and hardest reaching the ball-mill. The ore is thus better prepared for subsequent treatment. An ore assaying 15% of lead at the first battery of rolls at the Proprietary mill would assay only 10% of lead at the third battery. It is also claimed that less sliming takes place during reduction by this method. My own experiments with Block Ten ores showed that, when crushing to 3 mm., $6\frac{1}{2}$ to 12% of the material in series reduction would pass 100 mesh, while in single-stage reduction $10\frac{1}{2}$ to 14% would pass 100 mesh ; but, on the other hand, the power consumption per ton crushed was heavier in series reduction, being in the ratio of 1·8 to 1 in favour of single-stage reduction.

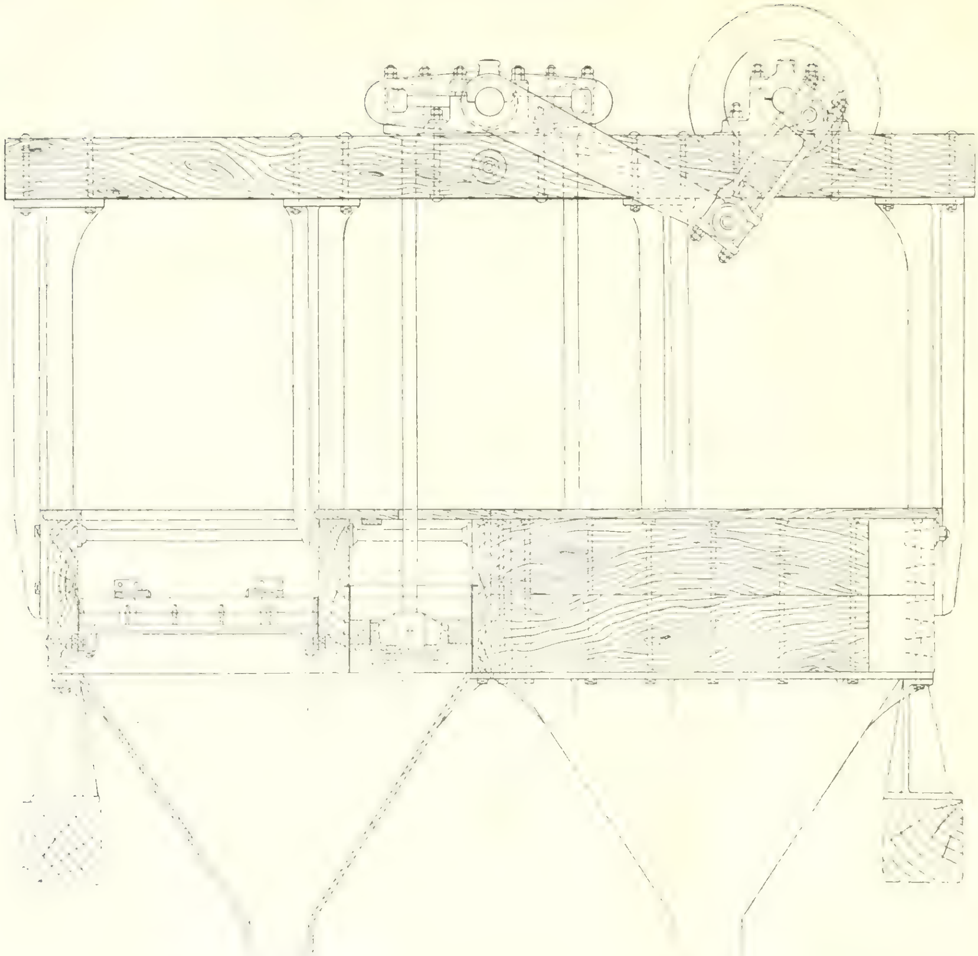
Following the example of the Proprietary and the Central companies the South discarded raff-wheels for elevators for returning the raffs to the rolls for further reduction. With the exception of the above, raff-wheels, some 14 ft. in diameter and driven from an extension of the roll-shaft, were in common use in milling plants on the field. They were dirty, cumbersome, unsatisfactory appliances at the best.

All launders carrying raffs in the South mill have a slope of 45° and are lined with 2 in. angle-iron placed transversely across the launders at 12 in. intervals to prevent scour and wear on the launders. The gearing, framework, boots, and hoppers of all elevators are standardized throughout the mill. The elevators are driven from the top pulley ; and it is a matter for remark that a geared drive should have been retained in the South mill when modern millmen have found it advantageous to substitute direct drive for the geared. The elevators for raising the raffs have buckets or hoppers 15 in. wide, bolted at 14 in. intervals to a belt 16 in. wide travelling at a speed of 358 ft. per minute. Top pulleys are 2 ft. 6 in. and bottom pulleys 3 ft. in diameter ; the distance between pulley centres is 40 ft. Elevators with 13 in. buckets spaced 13 in. apart on belts 14 in. wide with pulley centres 47 ft. apart and speed of 358 ft. per minute raise the trommelled ore to the King screens situated above the jig heads in the four sections of the mill.

Jigging Practice.—Of all classes of jigs from various countries of the world tried on Broken Hill ores that of May Brothers, Gawler, South Australia, has proved the most simple, effective, and economical. It is common to all gravity mills on the Barrier. Each section of the South plant contains one May duplex three-compartment jig. Of the Hancock jig, which was displaced on the Broken Hill field by the May jig, it should be stated that the former has proved highly successful in treating coarsely ground—$\frac{1}{4}$ in. gauge and upwards—copper ores from which it produces extraordinary large tonnage of good-grade concentrate with satisfactory recovery. The jig, in contradistinction to the May, is one in which the necessary pulsations are created by the rise and fall of the sieve itself with its contents in a large receptacle containing water. My unbiassed opinion of the Hancock jig is that it requires more intelligence on the part of the jigman, and is more expensive in upkeep and repair than the May jig.

In the earlier days of the Barrier, before the introduction of flotation processes and prior to the greatly increased use of Wilfley tables, it was the general rule for the primary, or coarse, jig to have five compartments on each side and to furnish a finished tail for the dump. The middling from the jig, after finer reduction in a ball-mill, was treated on a secondary, or fine, jig with five compartments on each side. The fine jig was similar in construction to the coarse, but had smaller hutches, finer mesh sieve, and smaller plungers which worked at an increased number of strokes per minute. I believe that to the South company is due the improved system of dispensing with the fine jigs and the substitution of tables for the treatment of the re-ground middling from the coarse jigs.

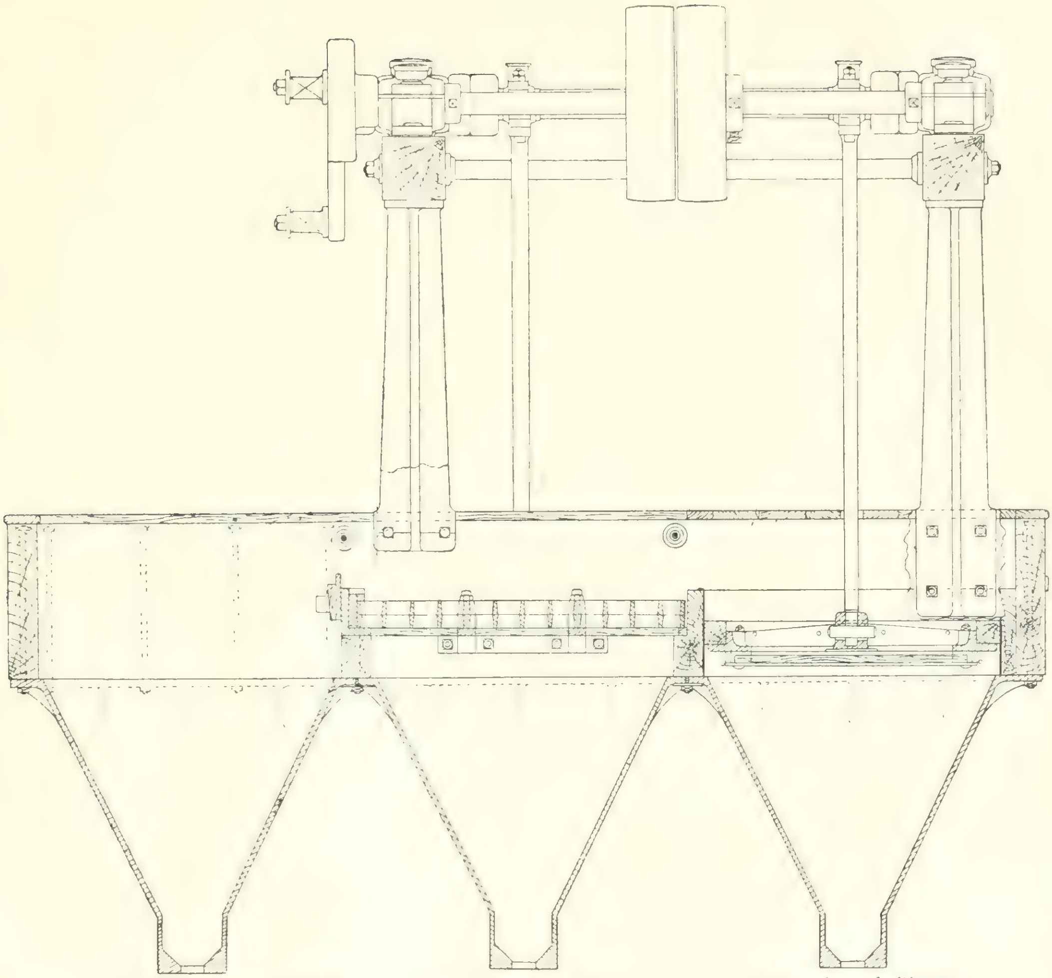
Each May jig, as now used by the South company, consists of two independent units of three hutches each, bolted on to a wooden



Half End Section through Gratings. *Half End Elevation.*

THE MAY JIG.

frame. The overall dimensions are 10 ft. $9\frac{1}{2}$ in. by 9 ft. 3 in. The first two compartments in either unit are divided into a sieve and a plunger compartment. The third hutch in each receives the tail and has neither sieve nor plunger; it is open. The sieves which form the bottoms of the outer, or sieve, compartments of each unit are 2 ft. 6 in. wide and 3 ft. $4\frac{1}{2}$ in. long. The grids upon which the sieves rest are of cast iron and three grids go to form one bottom. Each grid has an overall measurement of 30 in. by $13\frac{1}{2}$ in. by $1\frac{1}{2}$ in. deep. The grid openings are each 5 in. by $2\frac{1}{2}$ in. Upon these grids, when fixed in place, the woven wire sieve is laid, and is held down by top grids, made of brass, corresponding in dimensions with the grids below except that they have $\frac{1}{4}$ in. greater depth. The top grids are firmly fixed down on the sieve and lower grids; and the edges of the whole are tightly caulked. A layer of "ragging" about $1\frac{1}{2}$ in. deep, made from $\frac{5}{16}$ in. round bar-iron cut into lengths of about $\frac{3}{8}$ in. forms the jig bed on top of the sieve. Each plunger is 2 ft. $11\frac{1}{2}$ in. by 1 ft. $1\frac{3}{4}$ in.; it is constructed of cast iron and is edged with timber wearing-boards bolted to it through slotted holes in the cast iron, so as to allow of adjustment as frictional wear takes place. Each plunger has a clack opening under which is loosely bolted a light, pine clack-board. The clearance of the clack from the bottom of the plunger on the up-stroke is approximately $\frac{5}{8}$ in. The action of the plunger clack ensures a quick upward pulsation and a slow coming to rest of the particles being jigged. The plunger rods are of round steel $1\frac{3}{4}$ in. in diameter, fixed into a tapered boss on the plunger by a cotter pin. The driving gear, which



Section through Tail Hutch. *Section through Gratings.* *Section through Plunger.*

THE MAY JIG.

is carried on cast-iron standards and pine beams erected on the body of the jig, consists of a shaft 7 ft. 3 in. long by 3 in. in diameter, fitted with fast and loose driving pulleys. On the end of this driving shaft is a disc 15 in. in diameter with a radial slot, 6 in. by $1\frac{1}{8}$ in., in which fits a bolt carrying a crank-pin for the connecting rod to the arm of the rocking shaft. As the crank-pin may be moved to and fro along the slot, it serves to alter the stroke of the plunger when such is required. The rocker shaft is placed over the centre of the jig and is 7 ft. long by $3\frac{1}{2}$ in. diameter. Extending from this shaft are arms, 2 ft. 8 in. long, which are slotted at the outer ends. Each slot is fitted with bolt and crank-pin similar to those on the disc; and to these crank-pins each of the four plunger rods is attached. By moving the crank-pin along the slot in the arm the length of the stroke may be altered to suit requirements. Products from the jig pass continuously through spigots at the bottom of the hutches.

The following are the jig products :—From the first hutch, concentrate which goes to the lead despatch bins; from the second hutch, a middling which is returned to the rolls and thence comes back to the jig; and from the third hutch, a lead-zinc tail which goes to the grinding section for subsequent table treatment. The jig capacity is 12 tons per hour, and the number of plunger strokes per minute is 24. The assay values are as follows :—

Hutch.	Product.	Lead.	Oz. Silver.	% Zinc.	Destination.
1.	Concentrate.	67·2	22·4	7·1	Despatch bins.
2.	Middling.	38·3	15·3	18·4	Return to rolls.
3.	Tail.	7·6	4·3	14·6	Re-grinding department.

The tail from each jig is sent to four Forwood-Down grinding-pans, each 5 ft. in diameter. The pans are in parallel and the product from them is passed over four 16-mesh King revolving screens. The oversize from the screens is sent to four more grinding pans of similar size and type, set in parallel; and the product therefrom is returned to the same King screens, the undersize from which is sent to the tabling department. In one section of the mill . 14 ft. by 4 ft. 7 in. tube-mill, running at 28 r.p.m., takes the place of five grinding pans. Both Danish and South Australian flints are used in the tube-mill. The undersize from the screens is as follows :—

Mesh.	Aperture. mm.	% Weight.	% Lead.	Oz. Silver.	% Zinc.
+ 40	0.317	34·4	3·5	2·3	11·6
60	0·211	16·0	4·5	2·7	15·6
80	0·157	6·9	5·1	3·1	16·6
100	0·127	5·4	5·1	3·9	16·8
150	0·084	11·0	9·1	5·0	16·6
— 150	0·084	26·3	15·4	8·0	16·4
		100·0	7·6	4·3	14·6

(*To be concluded.*)

MINERAL RESOURCES OF LOWER KATANGA, BELGIAN CONGO

By G. TREFOIS and J. HENRY RICKARD

(*Concluded from November issue, page 280.*)

Copper.—As already mentioned, we do not touch on the copper mines of the Union Minière in this article, so we confine our remarks to the Urua or other copper deposits in Southern Katanga not owned by the above-named company.

The Katanga natives have mined and smelted copper for many generations, and even now the production from native mines must be considerable. The metal is turned out in ingots shaped like a Maltese cross weighing about 10 kilos. It is used as barter, and finds its way right through Central Africa, even as far as the Soudan. Thus the Baluba tribes, who are the metallurgists of the country, know the outcrops of copper so well that our prospectors have only had to follow these natives to find nearly all the known lodes or deposits.

It is well to state here that mining, up to now, has been confined to the oxidized or surface zones, and nowhere has the sulphide level been reached, until recently, in some trial or prospective workings, particularly near Lake Moero. The sulphide ores, which probably occur in depth, have not been touched.

The oxidized zone carrying oxides, carbonates, and silicates in the southern mines is rich, and yields ores averaging 15% Cu or m[illegible]. Elsewhere the copper contents of the outcrops is lower, about 4 to 5% Cu. The secondary enrichment zone under these outcrops gives better results, and assays about 10% Cu. At several points under gozzans, showing only slight indications of copper and some without even a trace, copper in the form of native copper, chalcocite, covellite, etc., was found at a depth of only a few metres. These occurrences, covered by a sterile capping, have evidently escaped the notice of the natives, and also the first white prospectors. To-day, however, by a more systematic study of the subsoil it is comparatively easy to locate them.

We are of the opinion that a new series of important copper mines will soon be developed in Katanga, and these will be mainly worked in the secondary zone for sulphides. This class of ores is more adapted to water concentration or flotation than oxides or carbonates. Moreover, the smelting of sulphides is less expensive as there is a great saving in fuel, and less metal is lost in the slag.

In the Kundelungu Mountains a series of conglomerate, schist, and limestone beds carry more or less copper. This formation is generally considered to belong to the base of the Kundelungu system, and it would seem that there exists here a Permian copper horizon similar to that which covers such a large stretch of country in Central Europe along the Hercynian chain of mountains, and which is found in other parts of the world. It is probable that these deposits are partly sedimentary, but according to present appearances they seem to have been displaced; thus the copper-bearing formation exposed must be

considered to have been changed by surface or epigene action. The beds are traversed by mineralized fractures which become sterile as soon as they go beyond the copper-bearing strata ; the strata are generally richer in copper near these fractures, which are not feeders but simply veins carrying copper from one stratum to another. Up to now only the surface or oxidized portion of the Kundelungu copper-bearing formation is known. The ores are malachite, azurite, chrysocolla, chalcocite, covellite, and a little chalcopyrite. In the conglomerates the mineral is associated with the cementing material. In the schists it occurs as coatings in the cleavages or fills up small cavities. In the sandstones it forms irregular impregnations with some compact stringers running in different directions. In the limestones the mineralization is most irregular ; the ores occur in bunches, separated by almost sterile rock. In the sandstones there are nodules of chalcocite. The ores, on the whole, are too low grade to be worked under present conditions, namely, costly transport and high price of coals or chemicals, but when the workings reach the secondary enrichment zone it is more than probable that higher grade ore will be discovered.

In the Lake Moero district several similar deposits have been partially prospected, and also another type near the granite formation. The copper ores are found in a bedded lode at the contact of granite, sandstones, and slates, which were supposed to belong to the lower Kundelungu, but they are evidently of an older formation. At the outcrops, the sandstones over a width of 15 to 20 metres are impregnated with copper ores especially malachite. The percentage varies, being sometimes as high as 12 to 15% Cu, but the average is not more than 4% Cu.

Near the Rhodesian frontier to the east of Lake Moero some open-cuts, made by one of our prospectors about 10 years ago, traced one of these lodes over a length of 3½ kilometres. These superficial trial works cut through sandstone carrying a little copper here and there, but on the whole it was poor. Later test pits were put down through the sterile portion of the outcrop. After sinking through a few metres of gozzan, the secondary enrichment zone was found containing chalcocite, native copper, etc. These ores are naturally richer and far easier to treat, from a metallurgical point of view, than those of the outcrop. In deepening the older workings it was found that the secondary enrichment belt continues and lengthens not only under the mineralized sections, seen on the surface, but also under the sterile portions ; in fact the richest finds are immediately below the barren outcrop or where the leaching of the copper from the upper part of the lode has been more complete.

Exploration has been commenced. The workings, which are still limited in extent, have opened up a fairly large tonnage estimated at 300,000 tons of ore averaging 7 or 8% Cu, which can be easily and cheaply treated. There is every reason to expect that developments will block out large quantities of rich ore running into millions of tons.

Other copper occurrences, in connexion with granite, have been found near Lake Tanganyika. They are in quartz lodes near granite or in metamorphic schists crossing the same formation. These lodes have been worked on, in times past, by the natives and by the Arabs, but not to any depth. They appear to be narrow, irregular, and poor in copper, but there is nothing on which to base an opinion as to what exists below the oxidized outcrop. Their geographical situation is very favourable for comparatively easy transport either by Tanganyika Territory or via Kabalo by the Congo. They are also near the Lukuga coal basin.

In the higher basin of the Lukushi River another discovery of copper ores in gabbro rock has been made. On the surface only small pieces of malachite were found in detrital matter. The gabbro rock shows slight copper stains in two spots where this rock crosses ravines. An open-cut found very good ore at a depth of 3 or 4 metres ; other pits on the supposed strike of the lode were sunk 8 to 10 metres or even more before reaching ore. These pits, after going through detrital, got into decomposed rock carrying no copper ; then they found a brecciated gabbro cemented together with quartz and copper ores. The deposit occupies a shearing zone in a gabbro massif which cuts through the red schist formation near its contact with granite. This zone forms an ellipse whose greater axis has a length of 300 metres and the lesser axis 100 metres. Near the periphery of the ellipse the gabbro is only moderately brecciated, but nearer the centre it becomes

more broken and brecciated. The mineralization is spread over the whole formation, but the richer ores occur along four veins of banded structure running parallel to the greater axis of the ellipse, particularly in the two central veins. In places these veins have every appearance of lodes with well-defined walls and flucans, but in others they are not so clearly defined. The width of workable ore cannot be easily estimated. For example, one finds solid veins of chalcocite 20 to 30 centimetres wide, but generally one has to deal with a brecciated matrix containing about 15% Cu over widths varying from 3 to 7 metres. The ore is mostly chalcocite with small alterations to malachite and azurite. The examination of this deposit is not finished, but it seems to offer every indication of containing a very large tonnage of rich ore easy to mine and to treat.

Near this deposit, some conglomerates, more recent than the gabbro formation and the granitic sandstone (arkose) which caps it, contain small quantities of copper. No trial work has been done here as yet.

The granite massif near the principal deposit appears to be highly mineralized for a length of about 120 kilometres and a width of 20 to 30 kilometres. The periphery of this belt is dotted with occurrences of tin, gold, copper, and iron ores ; also several hot mineral springs which deposit silica.

Outside the four groups already described (Kundelungu, Moero, Tanganyika, Higher Lukushi) several other cupriferous outcrops are known, but only very superficial tests have been made on them, and these have yielded low-grade oxidized ores, with rare occurrences assaying 15% Cu. The ore of the outcrops is principally malachite. Although the results obtained from the surface workings point to small and irregular ore-bodies, deeper mining should be undertaken to prove if secondary enrichment zones exist below, similar to those of Lake Moero.

It will be seen that prospecting for copper has taken a new and quite a different aspect owing to recent developments, and the finding of rich sulphide ores at a shallow depth. It would be well to re-examine all known deposits showing even traces of copper. We have a list of 95 localities with cupriferous outcroppings outside the copper mines owned by the Union Minière du Haut-Katanga.

COAL.—The similarity of the Katanga Palæozoic series of rocks to those of the Karoo in South Africa, and to those of Gondwana in India, both rich in coal beds, gave reasonable hopes of discovering some in our new colony.

Mr. J. Cornet called special attention to the Lualaba bituminous shales. Some trials were made in the districts of Stanleyville and Ponthierville, where a bed of schist gave by distillation a fairly good yield of oil. The demand for any sort of fuel is small in these localities and is easily supplied by cheap wood from the immense tropical forests ; thus mining operations have not been continued.

The situation in Katanga is quite different ; wood is scarce, and the railways and mines are already using a considerable quantity of coal. The Union Minière smelting works alone requires 100,000 tons of coke per annum, which is brought from Wankie, 1,200 kilometres away. The Panda ore concentration mill is burning many hundred thousand cubic metres of cord-wood yearly.

Prospecting for coal was commenced in the Lualaba schists, at a place which gave the name to this formation, that is to say, on the right bank of the Lualaba River near Bukama. Here are several outcroppings of carbonaceous shales. Trial shafts were sunk, but only showed a poor quality of lignite, considered to be of no commercial value, and prospecting was abandoned.

A few years later drill-holes were put down on similar shales, on the Lovoi, with the same results.

Soon after, there was a general commotion among prospecting companies by the discovery of the Lukuga coal basin, and immediately large areas were pegged on this and its supposed extension. The field has been well described by Mr. Fourmarier. It yields a fairly good lignite, which, however, does not produce metallurgical coke. Although there is every indication of very extensive coal reserves here, the mines cannot be worked on a large scale until the means of transport are improved towards the south. Locally, the fuel demand is very small.

In making the railway cuttings on the line Kambove-Bukama linking the southern mining district to the river transport by the Lualaba, another series of carbonaceous schists was discovered. The Railway Company and a Franco-Belgium association soon took up a large concession and commenced exploration on an extensive scale ; this work was retarded and eventually

suspended during the Great War. The geographical situation is advantageous, being, as before stated, on the railway between the southern copper mines and the Lualaba River. Here is found a coal basin going to a depth of about 100 metres. The coal-bearing seam increases as depth is attained and is estimated to have an average thickness of 25 metres, of which 5 metres is useful coal; though it contains some pyrites, it makes an excellent fuel, but like the Lukuga lignite the coke made from it is not a success. The exploitation of the seam is being conducted by both open-cut and underground workings. The sale price of the clean coal produced is only 30 francs per ton, comparing favourably with actual rates realized at home.

The Lualaba formation, with or without carbonaceous shales, has been discovered at several other places, but on account of a certain scepticism that succeeded a period of enthusiasm scarcely any work has been done on these new basins which warrant being tested.

Fuel has a very important future in Katanga, and in spite of the fact that the coal found so far has been classed as being unfit for coking purposes, a coke of better quality could be produced by using more up-to-date methods of carbonization, and it is possible that the coalfields not yet proved might yield a better grade coal than those in operation, for even from the Busanga to the Lukuga lignites there is a difference in the right direction.

The requirements for coal are already important. Up to now, railways, river steamers, smelting works, and other industries have consumed so much wood that the denudation of forests is becoming a serious question; so much so, that coal must come into general use. Several large hydro-electric plants are in project, but even when these are finished there will be an ever-increasing demand for fuel.

Katanga coal is rich in volatile matter, and gives valuable distillates for local consumption by the application of recently discovered processes now being used in the industrial world. The pulverized coal could take the place of coke in smelting ores, this theory being based on results obtained at Cerro de Pasco, in South America, with lignites of a similar composition to those under consideration.

	Katanga.	*Cerro de Pasco.*
	%	%
Ash	25·60	26·80
Vol. matter	34·32	40·05
Fixed carbon	40·08	33·15

At Cerro de Pasco pulverized lignite gives excellent results, both as fuel for boilers and also in furnaces for smelting and refining copper from the crude ores.

DIAMONDS.—The analogy already mentioned of the Katanga Palæzoic formation and that of the Karoo naturally drew the attention of geologists and prospectors to the possibility of finding diamonds in Katanga, as it was well known that most of the diamond pipes in South Africa are found in the Karoo system. Really, the geological period has little to do with these pipes, which are olivine flows (peridotites) posterior to the Karoo formation, and they continue in the older formation below.

There was, however, more than a sentimental reason attached to the importance of the Kundelungu system for the discovery of diamonds. This was the occurrence of huge dykes, or necks, of igneous rock, and also "pans," in fact, the identical surface indications and rocks as those found in the South African diamond fields.

A few diamonds were found in the alluvials of a stream which rises on the east slope of the Kundelungu mountains. A prospecting campaign following these indications resulted in the discovery of a certain number of kimberlite pipes near the eastern edge of the Kundelungu plateau. Later, other pipes were found on the western side of the same plateau.

Practically all the pipes discovered have been thoroughly tested and prospected. Diamonds were found in all of them, but in such small quantities and size that no one would attempt to work them.

In the alluvials of the Lualaba and some of its tributaries diamonds have been found, but no regular prospecting has been done.

A few years ago diamondiferous gravels were discovered on the upper Kassai River, and to-day the working of these alluvials is very remunerative. The success of this undertaking naturally called the attention of both speculators and prospectors to the western borders of Katanga, where the geological formation is very like that of the Upper Kassai. Systematic prospecting was lately begun by the Société Génerale de Belgique, and has already given very interesting results.

It is hoped that this new discovery may help to dissipate the pessimism of ever finding diamonds in paying quantities in Katanga, which theory arose from the poor results obtained in the Kundelungu, and

that prospecting on a wider field will be resumed.

While diamonds seem to be universally connected with peridotite magmas, kimberlite is not the only magma of this sort where diamonds have been found, and one should divert some attention to older olivine rocks, which are most probably the source of a large portion of the diamonds found in the South African river diggings. In other parts of the world these latter rocks appear to have a more important part in the genesis of diamonds than the so-called kimberlite formation, which has received undue attention by our Katanga prospectors because of the extreme richness of the Kimberley and other South African diamond fields.

As olivine rocks are found at many places within the province a systematic study of the alluvials near these formations should be made.

We have said that prospecting for diamonds has been resumed owing to the good results on the Kassai River. It is hoped that the chances of making it a success will not again be thwarted this time by taking the Kassai indications as the only guide to be followed, as was the case in the first discovery of the Kundelungu pipes, when kimberlite was supposed to be the only diamond-bearing formation.

OTHER MINERALS. — Frequently, concentrates obtained by panning stream alluvials in the granitic regions of Katanga contain monazite. It has generally escaped the prospectors' notice. Recently in the higher Lukulu, alluvials containing 2 to 3 kilos of monazite per ton of sand have been found. Cobalt occurs in some of the copper ores, and it is now proposed to extract it in the reduction works of Southern Katanga. As regards bismuth, none has been found worthy of notice. The lead lodes discovered are small and contain very little silver. Very little zinc has come under our notice. Copper ores in some places contain high uranium values. The iron ore deposits, which are very large, have not been worked, excepting on a small scale by the natives.

SUMMARY.—In reviewing the ore deposits now known in Katanga one might come to the conclusion that the country has not yielded all that was expected. However, the copper mines of the south are rich enough to class Katanga as a mining province of no mean order, and it will become one of the principal producers of the world.

The tin deposits, which are gradually being developed and put on a producing footing, will soon give a large output.

The present outlook for further discoveries and development of copper, tin, and diamonds are most encouraging.

We must not forget that prospecting was commenced only eleven years ago, and it was practically suspended during the Great War. Then again the rivalry between the several prospecting companies led to a lot of rushing from one point to another to peg leases and beacon concessions, for it was a question of being the first on the ground. This naturally led to some ill-feeling, unnecessary rush, and loss of time and money. It is only recently that more methodical trials have been commenced. Now that the four of five great prospecting companies have acquired large concessions and more ground than they can adequately deal with from a mining point of view, one can reasonably expect that more methodical and closer prospecting will become general.

Some ten million francs have been spent in prospecting and mining in the Urua. The ore deposits found more than justify this expense, and it is certain that by working with method and discretion better results are still in store.

Further capital will be required not only to equip and work the mines on the ore deposits already discovered, but also to carry on prospecting. Thus there is room for the investor and the speculator.

The country is not exactly one for the "one man" prospector at his own expense. The means of transport are slow, costly, and uncertain in the bush, as everything in the way of provisions, tools, etc., has to be "head-packed" by native carriers under supervision of special headmen. This state of affairs will gradually improve, but a prospector's job will never become an easy or attractive occupation.

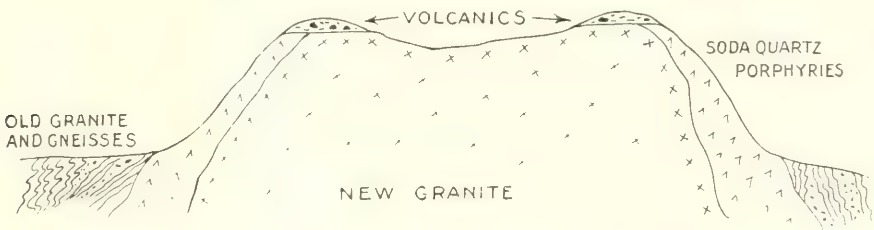
The Institute of Metals

The Secretary of the Institute of Metals announces the publication of a Name and Subject Index to the *Journal of the Institute of Metals*, vols. i to xxv. This index contains over 20,000 references, and covers metallurgical work done between the years 1909 and 1921. It is intended to meet the requirements of users and manufacturers of non-ferrous metals and alloys, and of persons engaged in research, teaching, or other spheres of work connected with non-ferrous metallurgy.

GEOLOGY OF THE LIRUIE HILLS
NORTHERN NIGERIA

By G. GORDON THOMAS, F.G.S., A.M.I.P.T., Assoc.Inst.M.M., and
J. L. VITORIA, Assoc.Inst.M.M.

The ancient town of Liruie is situated practically in the centre of a compact group of hills in the southernmost corner of the Province of Kano. It is approximately 20 miles N.E. of the Bauchi Light Railway Station of Kudaru, and is about 60 miles from both Kano and Naraguta in almost opposite directions. From Kudaru to the hills there is a second-class road passing through thick "orchard bush." The country around is thinly populated, which can be accounted for by the fact that this district was a favourite hunting ground for slaves of the Emirs of Kano and Zaria prior to the advent of the British. Little cultivation is done although the soil is rich and yields prolific crops where farmed.



Rough Section of Liruie Hills.

The Liruie Hills consist of an irregularly shaped mass rising abruptly about 1,000 ft. above the plains. The marginal hills are the highest, and form roughly a rim with an irregular depression within. Four main streams rise from this depression, making their way to the plains through narrow passes over falls.

The centre area of the hills consists of new granite, surrounded by a belt of volcanics which can be classified as rhyolites. Around these again are found the soda-quartz porphyries which form the steep escarpment of the hills above the plains, which consist of old granites and gneisses.

In the area of the new granite numerous quartz veins are found varying in width from the merest stringer up to 2 ft. ; and the majority of them are cassiterite-bearing. Some of these veins are found to penetrate the volcanics, but soon after penetration die out, proving these veins to be younger than the overlying volcanics. Good exposures of this occurs along the Maracco Road, where also the junction of the new granite and the volcanics is plainly seen.

Cassiterite occurs in this area, not only in the form of alluvial gravels and detritals, but also in the veins referred to and as impregnations in the new granite ; no cassiterite-bearing veins are known to occur in the older granites or the quartz porphyries.

The widest vein encountered is known as the Liruie Main Lode. It strikes in a S.E.–N.W. direction and has an average width of 16 in. over a distance of 2½ miles. This lode carries cassiterite and wolfram, and is well mineralized, containing a certain percentage of the following minerals :— zinc blende, copper pyrites, iron pyrites, galena, and columbite. Under adverse conditions during the war the senior writer won a considerable tonnage of cassiterite and wolfram from this lode, and further prospecting at depth may prove it to be of economic value in normal times.

Another feature of geological interest in this area is a large mass of laterite overlying the new granite. At the surface it shows the characteristic extremely hard gnarly structure, is dark red in colour, and is often interspersed with lumpy vitreous quartz, which sometimes contains cassiterite crystals. Below the hard crust the laterite becomes softer and more clayey. Running through this mass of laterite are found narrow veins of cassiterite-bearing quartz. These veins average as a rule 4 or 5 in. in thickness ; they are sometimes pinched to 1 or 2 in., in which case they consist entirely of cassiterite, somewhat brittle,

and breaking off easily from the surrounding earthy laterite. Unfortunately these stringers are not at all persistent, appearing and disappearing with great irregularity. At one spot, Karre Mutu by name, a number of these veins and stringers meet and cross, forming a stockwork and giving rise to considerable cassiterite enrichment at the junctions. Much alteration and silicification has also taken place in the immediate neighbourhood of the stockwork veins, and the resultant altered rock is much impregnated with fine grains of cassiterite. The lateritic character of the mass has disappeared under the altering influences, although the deposit, before being found, was covered by the cemented ironstone capping. Out of the zone of alteration the laterite retains its usual structure. The deposit has been worked to a depth of some 40 ft., and at this depth the veins continue to be cassiterite-bearing, but on the strike they thin out and become barren. No wolfram or any other mineral than cassiterite has been found in these veins.

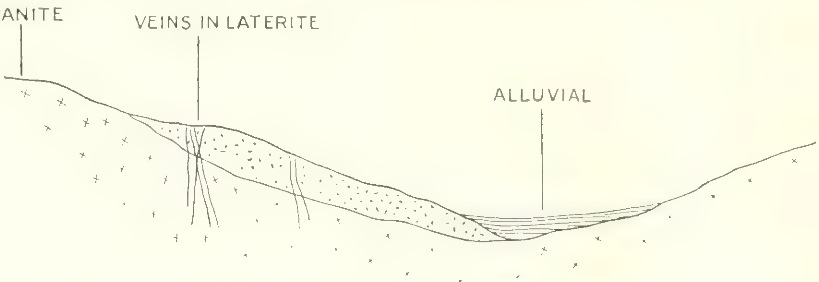


DIAGRAM SHOWING LATERITE FORMATION.

Surrounding the new granite is a belt of volcanic rocks. In places some of these rocks have a marked flow structure. This is particularly noticeable on the Maracco Road, which lies on the south side of the hills and goes through one of the passes through which a river runs. Also rocks of a breccia nature are present.

The highest point in this group of hills is known as Satu Hill. This hill consists almost entirely of volcanic rocks, and it is probable that it formed the principal vent from which the surrounding volcanics originated and flowed. From the topography it would appear that when these volcanics flowed out of this vent, or other vents, these hills were more or less covered by the volcanic flow, the entire mass forming a dome or boss. As the result of denudation what we find to-day is a ring of hills topped by the volcanics, surrounding the central area of new granite. It is the senior writer's opinion that the volcanics do not go very far below the surface when one gets away from the vents.

Speaking generally these volcanic rocks can be classified as rhyolites, and they are approximately of the same composition as the new granites referred to but cooled under different conditions. At the junction of the new granite and the overlying volcanics there is a marked tendency for patches of quartz to occur. This quartz is of a particularly white, vitreous, massive kind and is generally associated with large felspar and mica crystals, thus forming a pegmatite. In these patches showey masses of cassiterite have been known to occur. As the surrounding country is covered by volcanics it is difficult, if not impossible, to say if this change was caused by the laying down of the volcanics or was due to the intrusion of the younger granite against the soda-quartz porphyries. The senior writer is rather of the opinion that the latter is the case, that these pegmatites are a junction formation between the two rocks, and that the volcanics occurring where they do is merely due to a coincidence in denudation. As the surrounding country is hard volcanic rock it is impossible to prove this without going to considerable expense.

Proceeding still further out on to the outer edge of the volcanics, one comes to the soda-quartz porphyries. It is these rocks that form the escarpment of the Liruie Hills, which in some places is very steep. The surrounding plains consist of older granites and gneisses.

The writers would like to take this opportunity of thanking the trustees of the debenture holders for the Kano (Nigeria) Tin Areas, Ltd., for the assistance they have given in allowing them access to plans and reports.

THE GEOLOGY OF EAST POOL NEW SHAFT

By E. H. DAVISON, B.Sc.,

Lecturer in Geology and Mineralogy at the Camborne School of Mines

By the kindness of Mr. M. T. Taylor, manager of the East Pool and Agar mine, I have been able to visit the new shaft from time to time and keep a record of the rocks passed through in sinking. I give herewith a description of the geology of the shaft from surface to a depth of 720 ft., which was reached at the end of September.

Work on the shaft was commenced in January of this year, actual sinking being commenced toward the end of February. The shaft is situated to the north of the old Wheal Agar shaft, that is, on the north side of the Camborne-Redruth road, between Pool and Illogan Highway. The shaft mouth is 340 ft. above sea-level, and it is about 1,100 yards north of the edge of the Carn Brea granite.

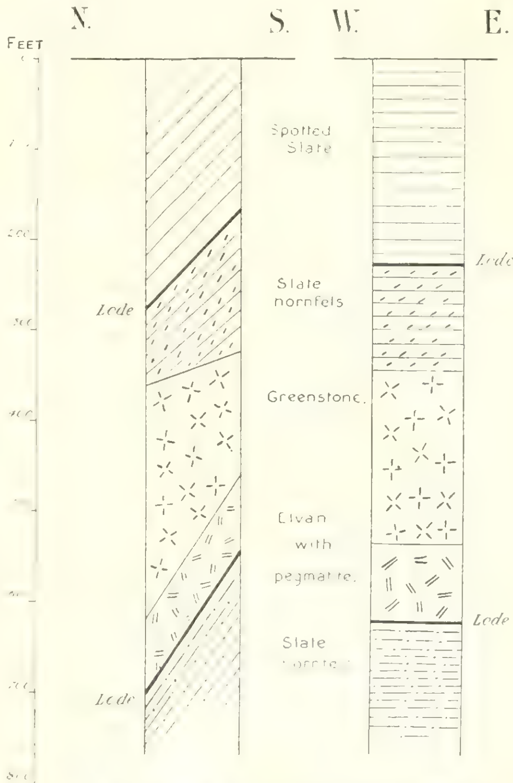
The first rock passed through was clay slate or "killas" of the Mylor series which, after a zone of weathered and decomposed rock was passed, was seen to be a grey rock, dipping north, with dark spots composed of biotite, tourmaline, and quartz, with films of mica along the cleavage planes, which are well developed. The rock can, therefore, be described as a "spotted slate" such as is common in the district within the metamorphic aureole of the granite. The microscopic characters of the rock are given in a later paragraph.

The shaft continued in this spotted slate down to a depth of 220 ft., where a lode was passed through, dipping north at about the same angle as the slates. This lode contained zinc blende, galena, and pyrites, with quartz and chlorite. There was also a little copper as chalcopyrite. Such a lode is the type one would expect to find just above the copper zone.

Below this lode the clay-slate became much harder and darker till it passed into a foliated biotite-hornfels, with films of blende, galena, and pyrite along its irregular cleavage planes.

At about 340 ft. this hard slate-hornfels, which had become harder with increasing depth, was followed by a tough, hard greenstone, or epidiorite.

The greenstone was of the type with which one is already familiar in the waste heaps of Wheal Seton and the railway cutting near Camborne station. It was veined with brown garnet, so that the whole rock had a coarsely foliated appearance, the bands being roughly parallel to the imperfect cleavage of the greenstone. It also showed veins of axinite, pale green pyroxene in coarse crystals, and patches of pyrrhotite and chalcopyrite. The greenstone mass dipped at a small angle to the



EAST POOL NEW SHAFT: OCTOBER, 1922.

north underneath the more highly inclined clay-slate. Blocks from the lower part of the greenstone showed narrow veins of quartz-porphyry which penetrated the basic rock.

At a depth of about 530 ft. the greenstone was followed by a dyke of elvan, which dipped north at a high angle. This rock was of a buff colour, and showed phenocrysts of quartz (many of them having hexagonal outlines), pink orthoclase, patches of radiating tourmaline needles, and occasional grains of pyrite, all these being enclosed

in a microcrystalline ground-mass. Thus the rock was a typical quartz-felspar-porphyry, which followed the habit of the great majority of these dykes occurring in the clay-slate to the north of the granite in that it dipped to the north.

In the porphyry there was a vein of granitic material having two main types of structure :—

(1) A coarsely crystallized pegmatite in which the crystals had vague and irregular outlines, showing well-developed graphic texture and composed of quartz, muscovite, orthoclase, lepidolite, and chlorite, with fine needles of tourmaline.

(2) A fine-grained granitic rock with similar composition to the pegmatite, but containing some biotite and a good deal of soda and soda-lime felspar. The occurrence of this granitic rock in the porphyry was at first puzzling, as the latter has always proved to be the younger rock, but the microscopic characters of the pegmatite and fine-grained granitic rock show that it has been subjected to heating subsequent to its crystallization, and there is little doubt that the granitic vein was formed before the porphyry which flowed past it and to some extent altered it.

On the foot-wall of the porphyry dyke, at a depth of about 620 ft., a second lode was passed through. This was sharply defined against the hanging wall of porphyry, and contained pyrite, chalcopyrite, blende, and mispickel, with chalybite, quartz, fluor, chlorite, and a little tourmaline. A few vughs were exposed which showed the order of deposition of the minerals. In one the succession was as follows :—Hanging wall of quartz-felspar porphyry ; (1) Chlorite ; (2) Quartz ; (3) Chalybite ; (4) Yellow, purple, and blue fluor ; (5) Chalybite crusted with small crystals of chalcopyrite and minute crystals of specular hematite.

The foot-wall of the lode was of slate hornfels of a different type from that of the hornfels above the greenstone. It was an almost black rock with dead black spots just visible with a coarse cleavage. It contained much biotite and tourmaline together with streaks and lenticles of pyrrhotite and occasional veins of actinolite, and at a depth of 720 ft. it contained a lode of grey quartz with mispickel, pyrrhotite, chalcopyrite, and blende, accompanied by hornblende, actinolite, and chlorite.

At the time of commencing this paper the shaft had not passed below 720 ft., but it is worthy of note that at a depth of about 760 ft. greenstone was met with a second time.

The author hopes to deal with the lower part of the shaft in a later article when the geological aspect of the shaft as a whole can be dealt with, but it is of interest to note that the characters of the rocks on passing down the shaft are in accordance with what one would expect from a section approaching the granite mass.

The occurrence of the granitic vein in the quartz-felspar porphyry is not exceptional as regards the distance from the granite mass at which such veins may occur. Granitic veins occur in the clay-slate on surface at Barncoose, which is about the same distance from the granite of Carn Brea as East Pool and Agar new shaft.

The author's thanks are due to Mr. Taylor for his help and facilities offered, and the section which illustrates this article was drawn from information given by him.

In the following paragraphs I give notes of the microscopic characters of the rocks :—

The slate hornfels from above the greenstone. —The rock is well foliated, the folia being folded in minute folds. They consist of layers of variable composition, including : Quartz biotite and tourmaline ; quartz and tourmaline only ; quartz biotite and muscovite ; black layers composed of iron ore and pyrite. The foliations are cut by veins of quartz with scattered grains of pyrite.

The greenstone.—The rock shows the following minerals : Plagioclase felspar, hornblende, garnet, pale green pyroxene in coarsely crystallized veins, with axinite, epidote, and pyrrhotite. It may be compared with the greenstones from Carrick du, St. Ives, and Trelavour Quarry, Penzance, which it resembles in its composition, all having been altered by the granite.

The quartz-felspar porphyry.—This shows phenocrysts of quartz and very turbid orthoclase, both occurring in idiomorphic crystals. There are also rectangular patches of chlorite after biotite with haloed inclusions of zircon and clear prisms of apatite. The felspars show carlsbad twinning, and include flakes of sericitic mica, patches of chlorite, calcite, and radiating sheaves of muscovite. The ground-mass is a microcrystalline aggregate of quartz, orthoclase, and muscovite, with a few grains of cassiterite.

The granitic vein ; coarsely crystallized pegmatite type.—Large crystals of orthoclase

with quartz penetrating it in graphic intergrowth, a little plagioclase (albite), muscovite, and chlorite with fine needles of tourmaline, and a little pyrite with a few grains of cassiterite. The junctions of the larger crystals are vague with a zone of indeterminate material which extinguishes separately from the crystal on either side, and undulous extinction is common.

The granitic vein: fine-grained type.—This has similar composition to the pegmatite but shows much more albite and contains a little biotite which is altering to chlorite. The crystals show the same vague margins and undulous extinction as in the pegmatite.

Each of these granitic rocks, especially the fine-grained type, is found to contain ankerite.

BOOK REVIEWS

A Text-Book of Theodolite Surveying and Levelling. By James Park. Fifth edition, revised and enlarged. Cloth, octavo, 557 pages, illustrated. Price 30s. London: Charles Griffin & Co., Ltd.

This is one of Griffin's well-known mining series, to which Professor Park, Dean of the Faculty of Mining in the University of Otago, New Zealand, out of his wide technical knowledge, has also contributed text-books on assaying, geology, mining geology, cyanide process of gold extraction, and hydraulics. His object here has been to supply the want of a handy treatise covering, with concurrent field-work, a two years' course in surveying for engineering and mining students, and for candidates preparing themselves for examination as licensed land surveyors in the United Kingdom and the Colonies. That he has successfully accomplished his purpose is evidenced by the steady demand which had led to the appearance of this, the fifth edition since 1908. The book has been entirely revised, reset, and much enlarged. Many new illustrations have been included, together with additional fully worked-out examples of problems in field astronomy and observations for azimuth, time, and latitude. The seventeen chapters into which it is divided deal with the following sections of the subject: The theodolite, chains and steel bands, obstacles to alignment, meridians and bearings, the theodolite traverse, co-ordinates of a station, calculation of omitted or connecting line in a traverse, calculation of areas, planimetry, the subdivision of land, setting out road angles and opposite sides, triangulation, the determination of azimuth, time, and latitude, stadia measurement of distances, railway curves, mine surveying.

The author traces the origin of the theodolite to the graduated circle, which was believed to have been known to Hipparchus, a Greek, who died 125 B.C. This is one opinion among many held with regard to the genesis of the instrument. About 2000 B.C. the Babylonians, through their ruling class, the Chaldæans, whose priests were famous for astronomy and mathematics, gave to the world many scientific conceptions, some of which no doubt have failed to travel down to us from that dim hinterland of history. To them we owe the signs of the zodiac, the division of the circle into 360 degrees, the division of the year into months, and of the week, day, and hour into the parts we still employ. They were equal, if not superior, in attainments to their Egyptian contemporaries, to whom it is customary to ascribe the earliest practice of surveying; and it hardly seems too bold to credit them with some rudimentary ideas on the problem of measuring angles instrumentally. Coming to times more accessible to research, there is evidence that Hero of Alexandria, 285-222 B.C., probably an Egyptian, but who wrote in Greek, may be regarded as the original inspirer of surveying as we know it. He invented the diopter and later another instrument which may be considered the forerunner of the theodolite of the present day; he also used plumb lines to orient a subterraneous survey.

Of the seventeen chapters, that on the determination of azimuth, time, and latitude is by far the strongest, occupying nearly one-third of the volume. The methods given for determining azimuth are those generally in use: Observing a circumpolar star at elongation, altitudes of sun or star on or near the prime vertical, equal altitudes of sun or star. For the reduction of extra-meridian observations the usual formula with the co-angles is given, no mention being made of the alternative formula of McElroy in which the direct angles are employed. This formula was first published in 1889, and has been republished in various periodicals since, in The Mining Magazine

of January, 1920, to mention one reference. It is preferred in the United States, and deserves to be much more widely known than it is.

The chapter on mine surveying deals with the underground portion of a surveyor's work. In discussing mining theodolites, the author gives special commendation to the transit designed by Professor L. H. Cooke, which he describes as one of the best of its kind, and one which has proved in New Zealand as useful for surface as for underground surveys. In underground traversing the common practice, it is stated, is to carry the bearing forward, and, after reading and recording the bearing to the forward station, to check the observation by setting the vernier on the back bearing to ascertain if the back station is intersected by the cross-wires, as it should be if the reading of the forward bearing and the making of the record were correct ; then unclamp the vernier plate and once more bisect the forward station, and thus check the forward reading and record. Perhaps a safer procedure is to observe the normal angle, then transit, and observe the explement. The two should sum up to 360 degrees plus or minus the permissible error. The bearing of the new draft can be calculated subsequently.

For connecting surface with underground by means of two wires in a vertical shaft the method advocated is to place the instrument to one side of the wires and recording an apical angle of about 30 degrees. Good results can be undoubtedly obtained with this arrangement, but most surveyors would prefer to rely on the Weisbach triangle, in which the instrument is nearly in line with the wires, recording an apical angle of very small magnitude. Neither this nor the excellent Roberts method is mentioned, although the latter has been a conspicuous success for many years in plumbing the deep vertical shafts of the gold mines of the Rand.

Very little importance is attached to the use of the loose needle, and it is recommended that no important surveys should be made with it. It is remarked that in India, Australia, New Zealand, South Africa, United States, and Canada, the compass has been superseded by the theodolite, and that in France, Germany, and the United Kingdom the compass is being displaced by the more accurate instrument.

It is inevitable that this should be so, because owing to improvements in the design and manufacture of instruments, higher examinational standards, and increasing value of territory, surveying is steadily progressing in the direction of greater precision, precision of an order unattainable with the magnetic needle. Before relegating the compass to comparative obscurity it would be ungrateful not to acknowledge its valuable services in the past, and unwise not to anticipate its help in the future. It is still a useful and sufficiently reliable instrument for many survey purposes, and one of its good points is that, compared with the theodolite, the law of accumulation of error is in its favour.

There are many matters coming within the purview of the underground surveyor in his ordinary routine which are not touched upon in this chapter, and its enlargement to include the more important of them would be a distinct advantage.

ALEX. RICHARDSON.

Tested Methods of Non-Ferrous Metallurgical Analysis. By SEYMOUR PILE and REGINALD JOHNSTON, with a prefatory note by C. T. HEYCOCK. Cloth, octavo, 150 pages, illustrated. Price 7s. 6d. London : H. F. & G. Witherby.

The authors of this book are associated with the Midland Laboratory Guild, Ltd., Birmingham, and the writer of the foreword is Goldsmith Reader in Metallurgy at Cambridge.

The book is arranged so as to give selected methods for testing metals, arranged in alphabetical order. The authors describe those methods which they have found to give the best results ; and included in each description of the process recommended are many small details of manipulation which tend to make all the difference between success or failure in trying a process for the first time. The book will be found quite useful, not only to the student but to the chemist engaged upon the analysis of metals for commercial purposes. Many of the methods described are those generally used in practice, but some are methods worked out by the authors themselves.

In the determination of silver in metals one is a little surprised that no mention is made of cupellation, to my mind the best method and much simpler than those described.

The methods of estimating sulphur seem to ignore the solubility of barium sulphate

in hydrochloric acid, far too much of that acid being left in the solution when the barium sulphate is precipitated.

The method of determination of sulphur in coals, etc., appears unusually long and tedious, and to differ from standard processes such as fusion with fusion mixture and magnesia.

In the chapter on white metals and bearing metals no mention is made of the method of attacking by strong sulphuric acid and potassium bisulphate, by which the antimony and tin and even lead may be determined in a much quicker way than by the authors' method.

One feature which should be improved in a subsequent edition is the method of illustration. Many illustrations are quite unnecessary, for instance, those of burette-stand and beakers; others are so rough that they are better left out altogether or freshly drawn.

Arthur J. Chapman.

☞ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, London, E.C. 2.

LETTER TO THE EDITOR

Crystallization of Orthoclase

The Editor:

Sir—Mr. Murray Hughes in the September Magazine raises a point regarding the crystallization of minerals from rock magmas that is of considerable interest. It is one, however, on which in the present state of our knowledge of the subject it is unsafe to dogmatize. We have usually no means of ascertaining which was the first mineral that *commenced* crystallizing, whereas we may often be sure of the order in which they *ceased* crystallizing.

Mr. Hughes refers me to Dr. Arthur Holmes. On p. 351, "Petrographic Methods" we find:—"A series such as obsidian, rhyolite, quartz-porphyry, granite-porphyry, porphyritic granite, and granite is likely to show a generalized order of the kind represented graphically in Fig. 58." Observe the very guarded way in which Dr. Holmes summarized the results of "modern research". In the next paragraph Dr. Holmes, referring to the diagrams in his Fig. 58, says:—"but it must be noticed that they are intended to be suggestive only, and that they are not quantitative."

Effusive types are included in the above list of rocks, whereas I referred to plutonic only, for they are the only ones in which the magma retained all its components and crystallized under fairly uniform conditions. Dr. Holmes deals with crystallization from molten rock in general; I referred only to granite. I am in accord with Dr. Holmes' views and also with the caution used in expressing them.

In my paper on "The Geochemical Functions of Water" I did not refer to the commencement of crystallization, for the subject is as yet too vague, and I was careful not to assert that orthoclase crystallizes invariably before quartz. I was dealing with crystallization from a eutectic mixture. If the orthoclase-quartz liquid in a granitic magma is a true eutectic it is obvious that that mineral which is in excess, and to the extent of that excess, will crystallize first, and thereafter both minerals will crystallize simultaneously. During this latter process the portion that is liquid at every moment will carry the eutectic ratio. We know, however, that the whole of the liquid from which orthoclase and quartz crystallize does not solidify in situ but that some is expelled, and that the composition of this final liquid fraction usually differs very much in composition from an orthoclase-quartz eutectic for, on cooling, it releases much water as well as other so-called volatile substances.

The Rosenbusch "law of decreasing basicity" is not a fundamental law; it was rashly conceived and should never have been enunciated. The acceptance of it has had a blighting effect on petrological thought.

There are chemical as well as physical reasons for the order in which crystals develop from magmas. It is our duty to discover them so that our beliefs may be based on real knowledge and not follow a rough generalization bred of pseudo-empiricism.

I have endeavoured to explain on chemical grounds (1) why silica exists free in granite and (2) why it is found in abundance in the last liquid fraction of a granitic magma. These are problems of fundamental importance in connexion with both magmatic differentiation and the origin of primary ore deposits. The question of the commencement of crystallization is of little more than academic interest.

J. Morrow Campbell.

Maymyo, Burma.
October 20.

NEWS LETTERS

KALGOORLIE, W.A.

September 30.

NEW FINDS.—As a result of the reduction of men on the big mines there are more men out prospecting now than there have been for some years, and a number of new finds have been made.

The leader of the big Government prospecting expedition reports having discovered gold at several points in a belt of country which they had been advised by the Prospecting Board to test on data supplied by the Geological Department. This is an answer of the critics who will never appreciate the practical value of that branch of the Mines Department. Owing to the protection given to the party, by the reservation of the area while they are at work, the party can thoroughly prospect the lodes, without being hindered by outsiders who rush a new find and peg the country for miles and then sit down on it.

A new find has been made about 15 miles west of Mount Singleton in the south-west of the Yalgoo Goldfield. It has been called the Retaliation Reward by the prospectors, Lewis and Carin, who report that at several points along the line of strike for a distance of half a mile, the lode is from 3 to 10 ft. in width and worth 15 to 30 dwt. per ton. A company has been formed in Adelaide to work it.

Another discovery has been made in the Marble Bar field by Captain McLeod, a one-armed returned soldier. Nine leases have been taken up and amalgamated. A company has been formed and £12,500 capital has been found by the issue of debentures to provide for a 10-stamp mill to treat the ore from the lode, and thus provide capital for its development. The debentures have to be all repaid before the shareholders receive any dividend.

This method is one to be commended, as the prospectors obtain work, and the men putting in the above capital will certainly get their money back even if the gold contents of the lodes decrease at a shallow depth. If on the other hand the lodes retain their value, then there will not be any difficulty in obtaining a large capital, and the prospectors and shareholders will retain a bigger interest than if they had sold before anything definite had been proved.

COPPER LEACHING.—The Government Assayer, Dr. Simpson, has been carrying out experimental work on the Nevill-Soanes process. [This process was described in the MAGAZINE for August.—EDITOR.] The Minister for Mines reported to Parliament that it had been found that a good extraction of copper could be obtained from the ore. But he refused to make Dr. Simpson's report public, as more information was needed by the patentees as to the cost of treatment, and it is understood that so far a satisfactory recovery of the cement copper from the pulp has not been secured.

Experiments are now being conducted by Dr. Simpson on the process proposed to be used on the Whim Creek mine as described in the MAGAZINE for July by H. R. Sleeman. The chemistry of the action of the ferric and ferrous salts on carbonate of copper ores is not yet fully understood. Some chemists consider the ferric to be the solvent, others the ferrous; an opinion expressed by one of our research chemists is that the interaction of one on the other forms a basic sulphate of iron and free sulphuric acid, which is the actual solvent.

It is hoped that as a result of the research work now being carried out under the supervision of Dr. Simpson, a great advance will be made in the successful leaching of copper ores.

The Pilbara Copper Mines are only waiting to find the most suitable process, before erecting a plant to treat the large tonnage of 4% ore available. If the treatment in dumps of coarsely crushed ore prove to be satisfactory, it will mean the opening up of big low-grade deposits not only in this State but in other parts of Australia.

KALGOORLIE.—The decision of the directors of the Lake View and Star company to spend £40,000 in the reorganization of their plant has been gladly welcomed. The Oroya Links company has shown what can be done in this direction on the Kalgurli plant which it recently purchased. The treatment has been simplified, labour reduced considerably, and instead of big steam-driven engines, a number of motors driven by electricity from a central power station are used wherever required.

HAMPTON PLAINS.—Owing to the scarcity of water the Celebration mine is just about holding its own, whereas with a better supply, good profits could be made.

A big make of water has been struck on the Hampton Properties Block 45 mine, and a Cornish lift has been erected. The

contract for the erection of a 10-stamp mill and sand and slime plant has been let, and the company should be producing gold as from the beginning of 1923.

The Syndicate which purchased the White Hope mine are quite satisfied with the results obtained from their treatment plant, which was erected at a comparatively small cost.

KIMBERLEY OIL PROSPECTS.—A report from Mr. Blatchford, Assistant Government Geologist, who is acting for the Freney Oil Co., reported on September 7 that an important development had occurred in the vicinity of Mount Wynne. Indications of asphaltum were seen in the Calyx drill core at 109 ft. and again in broken strata between 118 and 121 ft. Seams of asphaltum were found filling the joints. The fact that the asphaltum seepage had been found close to the crest of the dome, pointed to the conclusion that the oil rock from which it originated also lay in the structure, especially as the asphaltum is comparatively soft. A late report states that the traces of oil at a depth of 130 ft. are heavier than usual. It will be remembered that asphaltum (impsonite) was found on the Negri River on Okes Find, which is several hundred miles east from Mount Wynne. Boring work is being carried out on this area by the Okes-Durack Company, under the supervision of an oil engineer.

RICH CRUSHINGS.—There have been several rich crushings lately from old mines which are of interest, showing that there is still a return for men who are capable ore-finders. The Carbine mine at Kumanalling, near Coolgardie, treated 620 tons of ore for a return of £16,400. This mine was assisted under the Mines Development Act in 1904, and since then it has yielded 30,802 oz. of fine gold from 35,890 tons of ore, which is not a bad record for a mine owned and worked by three men.

The Cockshort lease, which is part of the old Bayley's Reward mine at Coolgardie, crushed 18 cwt. of ore for a return of 508 oz. of gold. At Culculli, near Meekatharra, 7 tons of ore from the Turn of the Tide lease returned 190 oz. of gold. This mine was worked down to water level some years ago and then abandoned. It was taken up by another prospector, who unwatered it, and secured the above crushing from below water level.

LEAD MINING.—The Surprise lead mine at Ajana has resumed operations, and it is producing about 220 tons of lead per month. The Narra Tarra and Wheal Ellen mines, belonging to the Fremantle Trading Co., are producing 140 tons per month.

ASBESTOS.—The Nor'West still continues to produce the bulk of the asbestos in the State, as only high-grade material can be exported. The Mines Department is making inquiries to ascertain the best method of concentrating the asbestos, which consists of short and longer fibres, and so is not saleable under present conditions. The quality of the asbestos near Roebourne is excellent, but very little work has as yet been done to develop it.

ALLUVIAL TIN.—A syndicate comprised principally of West Australian mining engineers sent Mr. Joseph Grigg, a graduate of the Kalgoorlie School of Mines, to the Federated Malay States to prospect some virgin country. The results of his work have been very encouraging, for he has found an area which contains alluvial tin of good percentage. He has asked the syndicate to send up a mining engineer to check-bore the area, before putting in a dredging plant. This is mentioned as showing the value of prospecting by a technically trained man, under the advice of a board of mining engineers. After an experience extending over many years the writer of these notes is convinced that prospecting and ore-finding should form portion of the School of Mines training with subsequent field-work. We have many able men who can mine and treat the ore, but very few have made a speciality of finding it.

BRISBANE

October 14.

AUDITOR-GENERAL'S REPORT. — The Auditor-General in Queensland, as in the other Australian States, is an officer of Parliament whose duty it is to report yearly on matters financial relating to the receipts and expenditure of the different Government departments. In the discharge of his functions he throws light on many transactions that would otherwise be kept dark, and often makes things awkward for the party in power for the time being. He reports separately on the numerous State enterprises initiated during the régime of the Labour Party now in power; this report for the last financial year (ended June 30) is not yet out, but his general annual report has just been published. In this he deals briefly with most of the State mining

enterprises, and his facts and figures on these concerns are such as, to say the least, are not likely to gain for the Government fresh supporters of their nationalization schemes. In fairness, however, it has to be stated that some of the enterprises that are showing heavy losses were never expected to make a direct profit, but have been "pro bono publico," or rather for the good of certain sections of the community at the expense of the whole.

State Batteries.—The Government now owns three State batteries and one battery and tin treatment works (Irvinebank). One of these batteries is on the Charters Towers goldfield. This plant has been only worked intermittently since its inception in August, 1919, because there has not been sufficient material for it to operate on regularly. To June 30, 1922, the expenditure on the battery has been £4,321, and the receipts £2,033. The excess of working expenses over receipts since the acquisition of the battery by the Government has been £206, and nothing has been written off the assets. The Bamford State battery in the Chillagoe district, erected by the Government in 1917 for treating the wolfram and molybdenite ores of that field, and afterwards provided with a tin-treatment plant, has been doing very little since the slump in prices early last year caused by the collapse of the metal mining industry. Up to the end of June last the total expenditure on this venture has been £19,948, and the receipts £6,489. Only 39 tons of ore was crushed last year, and the total loss, which had stood at £4,049 on June 30, 1921, had increased to £4,188 by the end of June of this year. A new State battery at Kidston, on the Oaks goldfield in the far North, has only lately been completed, and only 1,970 tons has been treated. The battery and treatment plant at Irvinebank, in the Herberton District, was bought by the Government from the Irvinebank Mining Company in 1919, and in the following year there was treated thereat for customers owning and working mines in the locality a quantity of ore that produced 250 tons of tin. Last year, however, the low prices ruling for metals caused miners to hold back their ore, and for the want of custom the smelter was closed down; but some work was thereafter done in the grading of ore and the keeping of the battery going for a time to provide concentrates. The actual financial position of these works to date has not yet been made known. During last year, however, the receipts were £16,801 from the sale of metals, stores, etc., and the expenditure was £15,355 for salaries, wages, and general expenses, together with £4,797 for the purchase of stores, or a total of £20,152.

State Coal Mines.—At the Bowen State coal mine, which has only just become productive on the opening of the railway from the Bowen River coalfield to the port of Bowen, there has been expended to date £55,984. On the Government's Baralaba coal mine, in the Central district, there has been a total expenditure of £39,324, while the receipts have amounted to £22,632, leaving a debit of £16,692. The coal production during the year was 24,711 tons. The Styx River State coal mine, mid-way between Rockhampton and Mackay, reached the producing stage in March last, and has since had an output of 3,606 tons. The total expenditure on the mine has been £27,735, and the receipts have been £12,793.

State Arsenic Mine.—The State arsenic mine at Jibbinbar, in the Stanthorpe mineral field, started operations in 1919, and had a yield of 285 tons up to August of last year, when the furnace was closed because supplies had outgrown the demand, and work at the mine itself temporarily ceased in the following November. Production was resumed in April last. On the mine and works there has to the present been spent £69,419, while the collections have totalled £20,013, leaving a debit balance of £49,405. The mine was started to assist farmers by providing at a low cost poison for the destruction of prickly pear, the price charged for arsenic for this purpose being only £10 per ton. For other purposes the price has ranged from £50 to £53 per ton, while from the beginning of July last it has been reduced to £45. The average cost of production has been £36 7s. 2d. per ton.

TORONTO

November 13.

Porcupine.—The power situation is causing some anxiety to the principal mining companies. There is already a temporary shortage owing to the breaking of a turbine at one of the generating stations. The Hollinger, Dome Mines, and McIntyre are only getting 85% of their regular allowance. It is feared that unless the open season continues for some time longer, accompanied by rainfall, conditions during the winter may become more serious. The three companies mentioned are installing auxiliary

steam plants, with the aid of which they hope to maintain the normal rate of production. It is expected that power from the new station at Sturgeon Falls will be available in February.

The Domes Mines during the six months ended September 30 realized profits of $970,297, after making heavy depreciation and reserve allowances. This compares with $1,244,922 for the entire previous year, showing an increase of 55%. Notwithstanding a repayment on capital and increased dividend, the company had in hand a surplus of $711,814. A pocket of extremely rich ore was recently encountered, and will add considerably to the average grade of the ore milled. Production during October was valued at $382,712.

The Hollinger Consolidated, during thirty-six weeks ended September 9, milled 1,015,289 tons of ore, with an extraction of $8,573,764. The average grade of the ore treated was $8·88, and the working cost was $4·11 per ton. The working force has been increased by the arrival from England of 120 Cornish miners, who were given employment.

During the three months ended September 30 the McIntyre produced gold to the value of $585,868 at an operating cost, including development, of $308,816. The mill is treating about 750 tons of ore daily, and will shortly be enlarged to a capacity of 1,000 tons. A new vein has been encountered on the 2,115 ft. level, in deepening the main shaft, carrying ore of exceptionally high grade. The geological indications point to a continuance of mineralization for at least another 2,000 ft. in depth.

The Clifton Porcupine has been unable to start its new mill, owing to the lack of electric power, and is putting in an auxiliary steam plant. The ore being broken for the mill shows an improvement in grade. The Vipond in cutting a station at the 1,000 ft. level encountered richer ore than any previously found. Cross-cutting at this level will be undertaken to reach the downward continuation of the ore-body developed on the 600 ft. level. At the Rochester three veins are in evidence on the 100 ft. level, one of them having a width of about 30 ft. of commercial ore, and another vein showing visible gold. The Porcupine Davidson has made a contract with the Matachewan Power Co. which will give them an adequate supply of power for the carrying out of their extensive plans for development. The plans of the Night Hawk for mill construction have been altered owing to continued favourable results of underground work, and the capacity of the mill will be increased to 400 tons daily. Preliminary work is being done, but the actual construction has been deferred until the spring. The Holtyrex has begun the sinking of a shaft. E. H. Walker, a prominent mining man of Boston, and associates have acquired extensive interests in the Porcupine district.

Kirkland Lake.—Production in this district during October was considerably curtailed on account of the destruction of about 12 miles of the power transmission lines of the Northern Ontario Light and Power Co. by forest fires. The reconstruction occupied about four weeks, and was completed early in November, enabling operations to be resumed. The Lake Shore during September produced bullion to the amount of $30,865 from the treatment of 1,716 tons of ore, being an average of $17·98 per ton. The work of enlarging the shaft has been completed, and it is being put down to the 800 ft. level. The Kirkland Lake Proprietary during September produced approximately $26,000 from the treatment of about 2,100 tons of ore. The face of the west drift on the 400 ft. level shows gold content of between $12 and $14 across a width of 5 ft. An offer has been received from New York capitalists, owning adjoining properties and advised by Mr. W. W. Mein, for the purchase of a controlling interest in the company, and a circular has been sent to the shareholders asking for their views. The new head-frame of the Sylvanite has been completed, and new hoisting equipment is being installed which will facilitate deeper mining. The main shaft of the Wright-Hargreaves has reached a depth of 800 ft., and will be sunk 200 ft. farther. The capacity of the mill has been increased, and it is now treating an average of 220 tons per day. The King Kirkland is carrying on lateral work at the 400 ft. level and is cross-cutting to strike an ore-shoot encountered at the 100 ft. level. The Hunton-Kirkland has let a contract to sink a shaft 100 ft. The main vein of the Bidgood has been cut at the 600 ft. level, and shows increased mineralization.

Cobalt.—During the earlier part of October the mines were idle for ten days owing to the destruction by fire of part of the

power-transmission lines. The Nipissing during October mined ore of an estimated net value of $151,665, and shipped bullion and residue of an estimated net value of $228,579. M. J. O'Brien, Ltd., has purchased the Bailey Customs Mill, which is now under the management of J. G. Dickenson. The mill will treat only the ore from the O'Brien mine, which will make it necessary for the La Rose to make new arrangements for the milling of their ore. The McKinley-Darragh has been drawing good ore from a wide open-cut, in which are a number of small high-grade veins. Prospects are good for a substantial profit on the year's work and the payment of dividends next year. The mill is handling approximately 4,000 tons per month. The Coniagas has installed a new mining plant at the Ruby, replacing that recently destroyed by fire. The Mining Corporation of Canada has leased the Farah property and begun development. At the Colonial the shaft is down 400 ft. A hoist has been installed enabling operations to be carried, if required, to a depth of 2,000 ft. The annual statement of the Trethewey shows a deficit of $1,199,137.

ROUYN TOWNSHIP.—Attention has lately been attracted to a new goldfield in Rouyn Township in Quebec Province, a short distance from the Ontario boundary, the formation of which is apparently the eastern extension of the Kirkland Lake gold belt. Numerous discoveries have been made during the last two months, and many claims staked. Two groups of claims have been taken over on option by the Thompson-Chadbourne interests, of New York, who will carry on work during the winter.

SOUTH LORRAIN.—Some very rich ore has been found at the Keeley mine at a depth of 480 ft. The vein, varying in width from 6 to 12 in., has been driven on for 40 ft., and it carries ore stated to contain from 4,000 to 14,000 oz. per ton, verifying the theories of the manager, J. Mackintosh Bell, as regards the possibilities of the property.

VANCOUVER, B.C.

November 9.

ROSSLAND.—A number of important mining deals have been made during the last month, but the most important and the one that will be of greatest interest to English readers is the bonding of the Le Roi No. 2 mine, at Rossland, to New York and Spokane interests. The deal was arranged by Douglas Lay, manager and representative for the company at Rossland, and Messrs. Tate and Daly, of Spokane. The price and terms have not been officially announced, but it is rumoured that the consideration is a million and a half dollars, to be paid over a period of three years. With the passing of Le Roi No. 2 from English toUnited States ownership the one-time extensive London interests in British Columbia mines practically have ceased, a fact that will be regretted by many people here. Still, it cannot be gainsaid that United States capitalists have a great advantage, owing to the nearness of the directorate to the seat of operations. It is understood that the new owners will develop and operate the property on a large scale and will add considerably to the present equipment. Le Roi No. 2 has been a splendid property, and has returned some good dividends to its owners. Of late years, however, comparatively little mining has been done, and, since the slump in the price of copper in the fall of 1921, work has been confined to picking over and concentrating ore that was piled upon the waste dumps before the flotation process had come into general use, and therefore was not ore in the proper sense of the word at the time it was dumped. This has been profitable, nature having assisted materially in the concentrating by decomposing the pyrrhotite without greatly altering the chalcopyrite, which carries most of the gold content of the ore. Since the beginning of the present year 285 tons of concentrate, obtained from the old dumps, has been shipped to the Trail smelter.

The Consolidated Mining & Smelting Co. has closed its Rossland mines entirely. For some time past only development work has been done at the mines, and now that several years' ore supply has been blocked out, it was thought wise to close the mines until the new concentrator at the Sullivan mine is finished. This will release the 1,000-ton concentrator at Trail, which now is being used to treat Sullivan ore, for the ores from the Rossland mines, and it has been demonstrated that it is more profitable to give these ores a preliminary concentrating before smelting.

The Consolidated company's examining engineers have sampled the Apex mine, and Clarence Cunningham, a well-known Slocan operator, has examined the Velvet and Cliff mines, so there is every prospect of a good deal of active mining at Rossland next year. The I.X.L. mine is still looking well ; the

last carload of ore sent to the Bunker Hill & Sullivan smelter gave a return of more than $12,000.

SLOCAN.—Subject to ratification by the shareholders at a meeting called for November 20, Henry H. Armstead, a well-known Cœur d'Alene operator, has purchased the whole of the stock in Utica Mines, Ltd., on the basis of 7½ cents per share, payable either in cash within 12 months or in shares in the Armstead Mines, at the option of the Utica shareholders. As well as the Utica mine, the deal included a number of mining claims near the head of Woodbury Creek, in the Ainsworth district. The new concern will be known as Armstead Mines, Ltd., and will have a capitalization of not less than five million dollars. Utica Mines, Ltd., has three million shares, which have beeen sold at prices ranging from 5 to 25 cents per share. For the last five years the Utica mine has been worked by lessees, some of whom have made large profits. Some of the richest silver-zinc ore found in the Slocan has been taken from this mine, but it is essentially a silver ore, and has been penalized in the past on account of its zinc content.

Roy F. Ainslie, of Syracuse, New York State, has bought the Galena Farm mine, near Silverton, for $60,000, payable over three years, and the Slocan Silver Mines, Ltd., has bought the Wellington group, at Retallack, for $16,000 cash.

Silversmith Mines, Ltd., has issued an attractive report, to inform its shareholders of the condition of their property and to celebrate its return to a dividend-paying basis of the company. It is not a regular annual report. The mine, which was the old Slocan Star mine, was restarted early in this year, and was gradually brought to full production by the beginning of June. Between then and the end of September the mine yielded a profit of $83,350, after accounting for all expenditures, including some capital expenditure, allowing for taxes, and writing off $40,000 for depreciation and depletion. On the average, 3,000 tons of ore, containing in round figures 25 oz. of silver per ton, 9% of lead, and 7% of zinc was crushed each month, and during the four months 214 tons of crude silver-lead ore, and 1,972 tons silver-lead concentrate were shipped to the smelter. No exact information could be given about the silver-zinc concentrate, as more than 2,000 tons was still on hand, the Trail smelter being unable to take all the production until the accumulation of past years at some of the other mines in the Slocan had been treated. For the year up to the end of October, Silversmith has shipped 5,160 tons of silver-lead ore and concentrate and 579 tons of silver-zinc concentrate to Trail.

Several of the Slocan mines have been shipping heavily, that is, compared with the last few years. For the year to the end of October the old Standard mine, at Silverton, has shipped 1,622 tons of zinc concentrate; the Bosun, at New Denver, 1,043 tons of lead and 21 tons of zinc concentrate; Rambler-Cariboo, 642 tons of lead concentrate; Noble Five, 417 tons zinc concentrate; Whitewater, Retallack, 433 tons of lead concentrate; and a number of mines have shipped more than 300 tons. Of course, these shipments are small compared to the old and prosperous days, but, as most of the ore has been produced since May, it indicates a distinct revival of mining in the district. There is a marked activity throughout the district, too; a number of old mines are being reopened, and new discoveries are being reported from all quarters. An important discovery is reported from the Cork-Province mine, near Kaslo, which, it is expected, will add greatly to the ore reserve. Milling ore has been struck at the Ruth, which is being reopened by a Vancouver syndicate and under the supervision of R. H. Stewart, formerly manager for the Consolidated company. Lessees at the old Standard have run into a four-foot lode of milling ore, and have shipped a carload of silver-lead concentrate. A five-inch vein of clean silver-lead ore has been struck at the Silversmith, which already had five years' ore reserve developed. Lessees at the Hewitt mine have run into what is described as one of the best showings of ore that has been opened in the Slocan for many years. A 14 ft. shoot of milling ore has been found at the Van Roi, and an excellent showing of dry silver ore has been found at the Reco mine.

THE CONSOLIDATED MINING & SMELTING Co. has posted a notice of a bonus that is given to the men at both mines and smelter, dating from October 1. It is to be based on the London price of lead and zinc for the previous month, and, judging by the notice, it will take a mathematician to work out how much it comes to each month. The October bonus will be 25 cents per man per shift. The company has erected a new foundry, adjoining its machine shop, with a view to manufacturing practically the whole of the

machinery for the Sullivan mine concentrator, arrangements having been made with the patentees for the right to manufacture all machinery that will be used.

PORTLAND CANAL DISTRICT.—The Granby Consolidated is still further adding to its interests in the Salmon River district. It has bonded the Outsider group, 35 miles south of Stewart and within a mile from tide-water on the Portland Canal, and the Sunshine group, about nine miles up Bear River from Stewart, and it has examined and is negotiating for the Daly-Alaska mine, which is situated on Fish creek, about seven miles from Stewart. The Outsider was located in 1903 and sold to the Brown-Alaska Company, which in 1905 shipped 14,500 tons of ore, said to have run 3% in copper with small gold and silver values, to the Hadley smelter, on Prince of Wales Island, Alaska. The Granby company has let contracts for development work at both the Sunshine and Outsider properties, and work will be continued steadily through the winter. Dating from October 1, the company increased its wage-scale 50 cents to all employees, and has abolished the old sliding scale based on the market price of copper.

The Premier mine is now giving employment to 250 men, and, besides the Premier, at least 15 properties will be operated through the winter. These will employ on an average about ten men each. United States interests have been busy in bonding and buying properties. J. Reinhert, of Seattle, has bonded the Sunrise group, at the Salmon River glacier ; R. J. Reibe and associates, of Seattle, have bonded the Silver Bell group, about half a mile above the mouth of Bear River ; a Seattle syndicate has bonded the Silver Cross group, at the head of Salmon River glacier ; and A. G. Larsen, representing Spokane interests, has bonded the Virginia and Torris groups, situated on the road to the Premier mine, and about 12 miles from Stewart.

Charles F. Caldwell, vice-president of Utica Mines, Ltd., and G. A. Carlson, a railway contractor, have made a reconnaissance survey up the Salmon River valley, with the idea of constructing a railway up the valley, and concessions will be sought from the United States and Canadian Governments with that end in view.

SMITHERS DISTRICT.—F. J. Duthie, who, with Seattle associates, has been developing the Mamie group, on Hudson Bay mountain, about 12 miles from Smithers, has opened up an excellent body of ore, and has sacked, ready for shipping, 5 tons of high-grade, assaying $1,800 per ton, and 200 tons running $200 per ton. This, of course, is picked ore, transportation conditions at present making it unprofitable to ship any but high-grade ore. The ore-body is large, and if it persists to reasonable depth the property promises to make one of the big silver producers of the Province. A survey is now being made for an aerial tramway to connect the mine with the railway.

ORE-TESTING PLANT FOR VANCOUVER.—The Hon. Mackenzie King has notified the Secretary of the Vancouver Chamber of Mines that the Dominion Government purposes to erect an ore-testing plant to be operated in connexion with the University of British Columbia.

SOUTH AFRICA

November 13.

MINING COSTS.—The average working costs of 19s. per ton recorded by the Barnato group for October is a creditable achievement. The mines of the group cover all districts of the Rand and are representative of old and new methods. The yield of ore milled, in dwt., has not fallen. Results give the evidence we have sought of genuine and stable reorganization on radical lines, and although Rand companies still owe much of their strength to the price of gold, there is a healthiness about their returns unobservable for years past. The Labour Party leaders point to the present valuation of gold at 92s. as a kind of breach of faith, suggesting that the threat of a par valuation was used deceptively against them before the strike, and that with the premium actually enjoyed no need for drastic reorganization existed. Arguments about working costs and premiums were helpful for public education, but, essentially, the industrial revolution was brought about by the demand for renewed efficiency, honesty, and discipline, without which no mining can be permanently undertaken anywhere in the world.

KNIGHT CENTRAL.—Even the reforms of 1922 have been unable to save the Knight Central mine, which has been worked with the utmost economy, and during the last few months has shown small profits, consequent upon the abnormal costs associated with the closing down of a mine. Naturally, this stoppage, in a month or so, will be a serious blow to Germiston, and Colonel Creswell has attempted to profit by the occasion by

reiterating his doctrine that the mine should be taken over by the State and the plant purchased at break-up price. It is really amazing that the leader of a political section which has now repudiated the International Commission of Tom Mann should support a policy of penalization for the long-enduring shareholders of a low-grade and now unpayable mine. If mining speculators develop a rich mine, they must employ superfluous whites and be taxed and supertaxed until the distributable profits drop to a Government basis of interest. If they are unfortunate, and lost a fortune in efforts that have benefited labour and storekeepers alone, even their pumps and winding engines are virtually to be confiscated. This is the policy advanced by Colonel Creswell, an English mining engineer leading the Labour Party, in a young country starving for the development of new industries, while the personification of industrial progress and national ambition is the "Boer general," J. C. Smuts; an anomaly that is the more remarkable because of the personal sincerity behind it.

DUST ALLAYING AND VENTILATION.—The committee formed by the Mines Department and Chamber of Mines has issued a final report (if finality can ever be reached in investigations bearing on phthisis conditions) on the subject of dust-allaying appliances and results, amplifying previous conclusions. Bearing on their view that ventilation of dead-ends is of the greatest importance and that reliance on the water-blast should be limited, the committee finds that the ventilation of a dead-end, before entry after blasting, should involve a quantity of air not less than the volume of the end, and that the dust conditions in development should be improved to the standard maintained in stopes. One water-blast should be used in each development end not more than 50 ft. back to effectively damp the face and broken rock.

IRON AND STEEL.—The report of an amalgamation between the Union Steel Corporation, of Vereeniging, and the South African Iron and Steel Corporation, of Pretoria, cabled from London, is received with wide satisfaction. The industry will have a hard enough struggle in facing outside competition and there is no room for internal competition at present. A combination of forces, assisted by the Government bounty of 15s. per ton on pig iron plus 15s. per ton on steel, may lead to activity on new lines. The bounty is granted only if 50,000 tons of iron or steel are produced from South African ore.

The Union Steel Corporation has been producing, with varying success, for years, but South African ore has so far played small part in the industry. The Pretoria company, with good deposits, announced a programme last year of erecting a plant of 75,000 tons annual capacity, at a cost of £2,500,000, when finances allowed.

NEW RUSTENBURG GOLD PROSPECTS.—The need for caution in accepting the reports of valuable new gold deposits in the Rustenburg-Bechuanaland region has been well indicated by the *South African Mining and Engineering Journal*, which fulfilled a good purpose by sending a technical representative to the area. As previously reported, the vein being tested on Kameelboom and Batavia belongs to the Ventersdorp series. It is an irregular and narrow conglomerate. Good pannings and good assays are confirmed, but more exactitude should be attempted by parties in control. The extent of work accomplished is adequate for an averaging of widths and values, if these matter-of-fact figures can be published without disaster to the field.

RAND MINING AND METALLURGICAL PRACTICE.—All advances in Rand mining and metallurgical practice have been, for several years, matters of gradual evolution. Developments often have been slow, as in the case of ventilation and dust-allaying. Even in such elementary factors as drill steel and explosives, improvements are attainable. Well organized and promising tests have lately been undertaken in regard to the gauging of successive steels in rock-drilling. Now we hear of more revolutionary progress promised in the automatic control of drill tempering, whereby the steel, on reaching the critical temperature and losing its magnetism, is drawn out of the furnace by springs. Until this temperature is reached the drills are held in position by magnets at the back of the furnace. Work is still experimental, and when comparisons are made with hand tempering it is well to remember that in this practice there is scope for improvement by more education. Nevertheless, "perfect" tempering and "perfect" gauging of drill steels are objectives worthy of considerable expenditures.

Under the head of metallurgy, the progress of all-sliming at the Springs mines is the feature of the day. The consulting engineer

has expressed himself well satisfied with the results of test operations on 41,000 tons treated since May. In this experimental section, tube-mills take the crushed product direct, and amalgamation and sand treatment are eliminated. An extraction of 95% is claimed, at a cost of 3s. 6d. per ton. An authoritative paper on developments, supported by all assays and grading analyses, should be forthcoming shortly, a timely sequel to Mr. Bosqui's paper on Rand metallurgy of ten years ago.

MINE TAXATION.—The small respect in which the Provincial Councils of South Africa are held by the majority of educated people has been further reduced by the recent futile efforts of the Transvaal Council to bleed the mines through an employers' tax. All employers, whether individual or company, of over eight persons were to be liable on a per capita basis. Apart from its activities as a machine for influencing votes in the Parliamentary elections, the Transvaal Provincial Council concerns itself chiefly in roads (inadequately) and in education (extravagantly). The gold mines were saved from the Council's tax-gatherers by the Union's restrictions, whereby taxation on the product, income, or profits derived from mining operations was vetoed. The employers' tax was a slim attempt at evading these restrictions, and the Crown Mines, Ltd. undertook to contest its legality. The Courts have now declared the tax to be ultra vires, whereby the Provincial Government loses costs, tax, and dignity, but none of its determination, no doubt, to add to the burdens of the mines by some other indirect method.

PERSONAL

A. S. ARMSTRONG has left Rhodesia Broken Hill, and is going to Queensland to take the management of the Chillagoe smelters.

R. GILMAN BROWN is the President-Elect of the Institution of Mining and Metallurgy.

SIR JOHN CADMAN has been elected president of the Institution of Mining Engineers for a second year.

GELASIO CAETANI has been appointed Italian ambassador at Washington.

G. W. CAMPION is home from West Africa.

G. T. B. COLBORNE has left for South Africa.

E. P. COWLES is here from the Rand.

ANDREW F. CROSSE, the veteran metallurgist of the Rand, is retiring from the active interest of his profession, and has closed his laboratory and consulting rooms at Johannesburg.

CARL R. DAVIS is here from South Africa.

U. A. GARRED has returned to the United States from Katanga.

PROFESSOR J. W. GREGORY has been awarded the gold medal of the Royal Scottish Geographical Society.

T. R. HAMBER is home from Nigeria.

W. SPENSER HUTCHINSON has been appointed professor of mining at the Massachusetts Institute of Technology.

S. ROY ILLINGWORTH has been awarded the degree of D.Sc. by the London University.

C. E. JOBLING has left for the Gold Coast to resume his duties as manager of the Prestea Block A.

G. C. KLUG has returned to Australia.

SIR ALFRED MOND has resumed the chairmanship of the Mond Nickel Co., Ltd.

H. C. ORFORD has returned from West Africa.

EDGAR PAM has returned to South Africa.

C. W. PURINGTON has returned to Yokohama from an inspection of the properties of the Ayan Corporation, Okhotsk.

JOHN ROGERS has been elected a member of the board of Nobel Industries, Ltd., in succession to F. J. Shand, who has retired.

GEORGE OTIS SMITH has resigned as director of the United States Geological Survey to take a prominent part on the Coal-Finding Commission.

DR. S. W. STRATTON, head of the United States Bureau of Standards, has been appointed president of the Massachusetts Institute of Technology.

A. R. THOMSON has left London on his return to Wankie, Rhodesia.

D. J. MACDONALD, of the firm of Innes, MacDonald, & Seale, died in West Africa on October 7.

R. C. GEMMELL, general manager of the Utah Copper Co., died suddenly on October 25, in his 59th year.

FRANK SHERMAN WASHBURN, chairman of the American Cyanamid Co., died on October 9, in his 62nd year.

TRADE PARAGRAPHS

CUTBILL, KING, & CO., LTD., of 32, St. Mary Axe, London, E.C. 3, send us particulars of a patent winding-rope socket which they are placing on the market.

HYATT, LTD., of 56, Victoria Street, Westminster, send us several new publications. One of these is a blotter, drawing attention to the lubricating feature of the Hyatt roller bearing; another deals with the bearing as applied to motor-cars; and a third gives a brief list of the company's line shaft bearings.

THE SULLIVAN MACHINERY CO., of Chicago (London Office: Salisbury House, E.C. 2), have issued two new Bulletins. No. 74A deals with their drill-steel furnace for use with oil or gas fuel. No. 70Y describes their valveless stoping drills, DT 44 light stopers, and DT421 automatic rotating stopers of both dry and water types.

RUSTON & HORNSBY, LTD., of Lincoln (London Office: 46, Queen Victoria Street), have issued Pamphlet No. 4,249, which deals with the Ruston No. 10 Universal Excavator, and Pamphlet No. 4,318, describing the Ruston No. 30 Steam Shovel. The Universal Excavator can be adapted for use as a crane navvy, loco crane, grab crane, dragline excavator, or trench excavator.

COOKE, TROUGHTON, & SIMMS, LTD., is the name of a new company formed for the purpose of amalgamating the firms T. Cooke & Sons, Ltd., of York and London, and Troughton & Simms, Ltd., of London and Charlton. Both of these are old-established and well-known for their engineers', surveyors', and similar instruments. The head office of the company is 3 and 5, Broadway, Westminster.

THE WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, of 165, Broadway, New York, inform us that the scope of operations of their London Office, 2, Norfolk Street, Strand, W.C. 2, has been extended recently in a manner important to buyers in the British Empire. Hitherto, the field of activity of the London Office has been confined to the Continent of Europe; it has now been arranged that the office can seek and obtain business in the British Colonies.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, send us a copy of their *Edgar Allen News* for December. This issue contains an article entitled "What is Hardness?" by R. M. Leslie; a review of the firm's pamphlet on "Imperial Manganese Steel," written by S. Tullers; and an account of the use of "Helipebs" in grinding machines, these being a special product made of steel wire coiled into the form of a helix and then hardened.

VICKERS, LTD., of Vickers House, Broadway, Westminster, inform us that the resolutions passed by the shareholders in July last extending the powers of the company were confirmed by the High Court on November 21. The additional powers conferred upon the company include the following: The holding of interest in coal and iron mines, brick-works, quarries, etc.; the manufacture, etc., of locomotives, tractors, motor cars, aircraft, and other vehicles; dealing in explosives and the manufacture of all classes of optical and scientific apparatus; the construction of aircraft for commercial purposes, and of tramways, railways, roadways, bridges, tunnels, canals, hydraulic, electric and gas works, smelting works, refineries, kilns, cement works, quarries, garages, and aerodromes; the manufacture of by-products of the company's various industries and other chemical and natural products; the granting of pensions, etc., to any employees, and the establishment of institutions for their benefit; and the carrying out of research work.

THE GENERAL ELECTRIC CO., LTD., of Magnet House, Kingsway, London, W.C. 2, send us particulars of a novel lifting magnet equipment designed for special work at Bombay. Here a big pipe-line is to be erected and the pipes are to be made on the spot from steel plates shipped from England. The work to be done by the magnets, of which there are four, is the unloading of these plates. The duty of each magnet is to pick up four plates 19 ft. by 7 ft. 4 in. by $\frac{3}{8}$ in. thick, or five plates 15 ft. by 7 ft. 4 in. by $\frac{3}{8}$ in. thick, either one at a time or in the complete bundle. The plates will be delivered either into stock or into the bending machines one at a time. The magnets are arranged with special controllers, so that by varying the amount of current supplied to the magnet it is possible to pick up one plate at a time. For example, starting with one plate, it is possible to go to another pile and pick up a second, move on to a third pile and pick up a third plate, and so on, and to drop them off one at a time alongside each of the four machines.

METAL MARKETS

COPPER.—At the beginning of the month of November the standard copper market in London was fairly firm. This was mainly due to professional and speculative activity, for the large daily turnover of business on 'Change could certainly not be ascribed to genuine consuming demand, which remained comparatively restricted. The support was inspired by a feeling that whereas other non-ferrous metals had undergone a substantial rise latterly, copper had remained out of the movement, and it was thought that a rise was due here also. The heavy buying which took place pushed prices up to a small extent, but the substantial upward movement anticipated did not materialize. In consequence, the professional support was ultimately withdrawn, and quieter conditions supervened, values closing the month at a loss. Demand from English and Continental consumers continued dullish. Reports from America indicated a steady to firm market at first, the price of electrolytic in New York moving up from 13·70 to 13·87½ cents, but towards the end of the month a relapse to 3·80 cents was recorded. Consumers in America are quite busy, but they have latterly been inclined to hold aloof from the market, apparently considering that easier prices may be seen when the increase in world production makes itself felt. The expansion in South American output is of course a menace to the control exercised over the copper position by the United States producers. No material damage was done to the South American mines by the recent earthquake in that country, but had the opposite been the case, and production out there interfered with, we might have seen a hardening movement in copper values.

Average price of cash standard copper: November, 1922, £62 17s.; October, 1922, £62 16s. 5d.; November, 1921, £66 13s. 6d.; October, 1921, £67 8s. 1d.

TIN.—Standard tin prices underwent some violent movements during November. The previous month, it will be recalled, saw an almost uninterrupted rise of about £20. At the beginning of November the market showed signs of reaction, and values slipped back a few pounds; further strength followed, however, and on November 6 standard cash touched almost £187 10s. This proved to be the peak of the rise, and with the withdrawal of professional support and the introduction of a generally pessimistic note in the market, prices fell steadily, cash being quoted during the closing days at around £174. Various factors contributed to the less buoyant air of the market. The announcement by the Federated Malay States Government that they intended to hold their stocks for a profitable price, and to dispose of them as quotations proved suitable, may have discouraged operators from maintaining their support of the market, which had probably been based partly on hopes of ultimately acquiring control of the stocks in question. Furthermore, shipments from the East during the first half of the month were returned at the high figure of 4,500 tons, and this depressed sentiment somewhat. Demand from consumers underwent little change during November, English and Continental users taking only moderate quantities, while America refrained from giving the London market much

London Daily Metal Prices: Official Closing

Copper, Lead, Zinc, and Tin per Long Ton

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic	Wire Bars	Best Selected
Nov.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.
10	63 12 6 to 63 15 0	64 10 0 to 64 12 6	70 10 0 to 71 0 0	71 0 0	65 10 0 to 67 10 0
13	63 15 0 to 63 17 6	64 12 6 to 64 15 0	70 15 0 to 71 5 0	71 5 0	— —
14	63 7 6 to 63 10 0	64 5 0 to 64 7 6	70 15 0 to 71 5 0	71 5 0	66 0 0 to 68 0 0
15	63 7 6 to 63 10 0	64 5 0 to 64 7 6	70 15 0 to 71 5 0	71 5 0	— —
16	63 5 0 to 63 7 6	64 2 6 to 64 5 0	70 15 0 to 71 5 0	71 5 0	— —
17	63 7 6 to 63 10 0	64 5 0 to 64 7 6	70 15 0 to 71 5 0	71 5 0	66 0 0 to 68 0 0
20	63 5 0 to 63 7 6	64 2 6 to 64 5 0	70 15 0 to 71 5 0	71 5 0	— —
21	62 17 6 to 63 0 0	63 15 0 to 63 17 6	70 10 0 to 71 0 0	71 0 0	65 10 0 to 67 10 0
22	62 12 6 to 62 15 0	63 12 6 to 63 15 0	70 10 0 to 71 0 0	71 0 0	— —
23	62 0 0 to 62 2 6	63 0 0 to 63 2 6	70 0 0 to 70 10 0	70 10 0	— —
24	61 12 6 to 61 15 0	62 12 6 to 62 15 0	69 10 0 to 70 0 0	70 0 0	65 0 0 to 67 0 0
27	61 15 0 to 61 17 6	62 12 6 to 62 15 0	69 5 0 to 69 15 0	69 15 0	— —
28	61 10 0 to 61 12 6	62 7 6 to 62 10 0	69 5 0 to 69 15 0	69 15 0	65 0 0 to 67 0 0
29	61 12 6 to 61 15 0	62 10 0 to 62 12 6	69 5 0 to 69 15 0	69 15 0	— —
30	62 0 0 to 62 2 6	62 17 6 to 63 0 0	69 10 0 to 70 0 0	70 0 0	— —
Dec.					
1	62 5 0 to 62 7 6	63 2 6 to 63 5 0	69 15 0 to 70 5 0	70 5 0	65 10 0 to 67 10 0
4	62 5 0 to 62 7 6	63 2 6 to 63 5 0	69 7 6 to 69 12 6	69 12 6	— —
5	62 5 0 to 62 7 6	63 2 6 to 63 5 0	69 7 6 to 69 12 6	69 12 6	65 10 0 to 67 10 0
6	62 7 6 to 62 10 0	63 2 6 to 63 5 0	69 10 0 to 69 15 0	69 15 0	— —
7	62 10 0 to 62 12 6	63 5 0 to 63 7 6	69 10 0 to 70 0 0	70 0 0	— —
8	62 10 0 to 62 12 6	63 2 6 to 63 5 0	69 10 0 to 70 0 0	70 0 0	65 10 0 to 67 10 0

support. The Straits sold fairly steadily both during the advance and subsequent decline.

Average price of cash standard tin: November, 1922, £179 8s. 9d.; October, 1922, £170 12s. 4d.; November, 1921, £159 0s. 2d.; October, 1921, £156 10s.

LEAD.—The market kept very steady, and values closed the month practically unchanged from their opening level. The reason for this seems to have been that although consuming demand fell away considerably holders were not inclined to make any material concessions in their ideas of price. Arrivals some time back had a distinctly expanding tendency, as evidenced by the figures of United Kingdom imports returned by the London Metal Exchange, which give August imports as 14,703 tons, while 16,682 tons were imported in September and 19,951 tons in October. It is fairly obvious that all the increase was not absorbed, and in some quarters it is believed that certain quantities must remain in private wharves and warehouses. However, holders are not evincing any desire to press metal on the market, and ask a premium of about 20s. for spot. They still consider the future volume of supplies as an extremely problematical matter. The trend of prices during coming months will be almost entirely dependent on the scale of fresh supplies, since any marked revival in consumption is hardly to be looked for while present quotations rule. Shipments from Spain have latterly had a diminishing tendency, and although Australia should be able to turn out increased quantities of metal, continual labour disputes there are hindering both output and shipment. Mexico is the bright spot in the position, and given a reasonable amount of tranquillity in that country the expansion in production now manifest there may be encouraged. The possibility of larger Mexican shipments is probably the principal factor in the market operating against higher prices.

Average price of soft foreign lead: November, 1922, £25 12s. 2d.; October, 1922, £25 1s. 3d.; November, 1921, £24 4s. 10d.; October, 1921, £23 10s. 8d.

SPELTER.—Spelter values in London fluctuated within a small compass during the month, the chief development being a check to the upward movement which had for so long been in evidence. The high figures reached attracted American interest, and the report that makers there had contracted to deliver many thousands of tons of spelter to this side tended to dampen the ardour of the bulls. It was certainly time for a pause in the upward spurt, since values are now undoubtedly pretty high. Belgian output showed a further increase during October, aggregating some 11,000 tons that month, which is evidence of the stimulating effect of ruling prices on production. With both Belgian and American producers inclined to interest themselves as sellers on the London market, prices are likely to continue steady rather than firm. At the same time, a further advance is not out of the question, though it would probably be short-lived. The main question is now how soon the effects of increased world production will manifest themselves on the London market in the form of more generous supplies; until the latter are forthcoming, prices are unlikely to recede to any material degree.

Average price of spelter: November, 1922, £36 18s. 9d.; October, 1922, £34 0s. 6d.; November, 1921, £26 4s. 10d.; October, 1921, £26 10s. 7d.

ZINC DUST.—Prices have remained steady, as follow: Australian high-grade £52 10s., American 92 to 94% £50, and English 90 to 92% £50 per ton.

ANTIMONY.—The position has undergone no alteration. English regulus is steady at £27 to £29 10s. for ordinary brands and £33 15s. to £35 for special brands. Foreign material is not very active, with the spot quotation at £25 to £25 5s. ex warehouse.

ARSENIC.—Business is dull, as buyers are scarce at the high figures asked by sellers. Cornish white is nominal at £70 per ton, delivered London, while Continental material is quoted at £60 to £65.

BISMUTH.—Sellers encounter a steady demand at 10s. per lb. for 5-cwt. lots and over.

CADMIUM.—There are a fair number of inquiries

PRICES ON THE LONDON METAL EXCHANGE.
Silver per Standard Ounce: Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc Spelter	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Nov.
26 10 0 to 25 5 0	27 15 0	39 2 6 to 36 15 0	184 5 0 to 184 10 0	184 15 0 to 184 17 6	33	$32\frac{1}{4}$	92 3	10
26 5 0 to 25 2 6	27 10 0	39 2 6 to 36 17 6	182 7 6 to 182 10 0	182 17 6 to 183 0 0	33	$32\frac{13}{16}$	92 3	13
26 7 6 to 25 2 6	27 10 0	38 15 0 to 36 15 0	180 0 0 to 180 5 0	180 17 6 to 181 0 0	$32\frac{5}{16}$	$32\frac{1}{8}$	92 0	14
26 3 9 to 25 1 3	27 10 0	38 17 6 to 36 17 6	182 5 0 to 182 7 6	182 17 6 to 183 0 0	$32\frac{1}{4}$	$32\frac{7}{16}$	92 2	15
26 2 6 to 24 17 6	27 5 0	39 0 0 to 37 0 0	178 10 0 to 178 15 0	179 5 0 to 179 10 0	$32\frac{1}{8}$	$31\frac{7}{8}$	92 4	16
26 0 0 to 24 15 0	27 5 0	39 0 0 to 36 15 0	177 10 0 to 177 12 6	178 2 6 to 178 5 0	$32\frac{3}{16}$	$31\frac{7}{8}$	91 11	17
26 0 0 to 24 12 6	27 5 0	38 5 0 to 35 17 6	178 7 6 to 178 10 0	179 2 6 to 179 5 0	$32\frac{1}{2}$	$32\frac{1}{8}$	91 11	20
26 5 0 to 24 17 6	27 10 0	37 12 6 to 35 12 6	178 0 0 to 178 5 0	178 15 0 to 178 17 6	$32\frac{5}{8}$	$32\frac{5}{16}$	91 6	21
26 7 6 to 25 5 0	27 10 0	36 17 6 to 35 2 6	177 10 0 to 177 15 0	178 5 0 to 178 10 0	$32\frac{7}{16}$	$32\frac{1}{8}$	91 9	22
26 5 0 to 25 2 6	27 10 0	36 0 0 to 34 7 6	174 10 0 to 174 15 0	175 15 0 to 176 0 0	$32\frac{1}{2}$	$32\frac{3}{16}$	91 8	23
26 5 0 to 25 2 6	27 10 0	36 2 6 to 34 7 6	174 10 0 to 174 12 6	175 12 6 to 175 15 0	$32\frac{3}{16}$	$31\frac{15}{16}$	91 9	24
26 5 0 to 25 5 0	27 10 0	36 17 6 to 35 0 0	174 15 0 to 174 17 6	175 15 0 to 175 17 6	$32\frac{3}{16}$	$31\frac{13}{16}$	91 7	27
26 5 0 to 25 5 0	27 10 0	38 7 6 to 35 10 0	174 12 6 to 174 15 0	175 12 6 to 175 15 0	$31\frac{7}{8}$	$31\frac{5}{8}$	91 0	28
26 2 6 to 25 5 0	27 10 0	39 0 0 to 35 15 0	174 0 0 to 174 5 0	•175 0 0 to 175 5 0	$32\frac{1}{16}$	$31\frac{11}{16}$	91 1	29
26 0 0 to 25 5 0	27 10 0	39 0 0 to 35 15 0	174 0 0 to 174 5 0	175 2 6 to 175 5 0	$32\frac{1}{8}$	$31\frac{3}{4}$	91 3	30
								Dec.
25 17 6 to 25 0 0	27 5 0	37 15 0 to 35 2 6	175 0 0 to 175 2 6	176 0 0 to 176 2 6	$32\frac{3}{8}$	$32\frac{1}{16}$	91 4	1
25 17 6 to 25 0 0	27 5 0	38 0 0 to 35 10 0	174 5 0 to 174 7 6	175 7 6 to 175 10 0	$32\frac{3}{16}$	$31\frac{15}{16}$	91 1	4
25 17 6 to 25 0 0	27 5 0	38 7 6 to 35 15	176 0 0 to 176 2 6	177 0 0 to 177 2 6	$32\frac{1}{16}$	$32\frac{1}{16}$	90 10	5
25 17 6 to 25 2 6	27 5 0	38 15 0 to 35 15 0	179 5 0 to 179 7 6	180 10 0 to 180 12 6	$32\frac{1}{8}$	32	90 7	6
26 0 0 to 25 5 0	27 5 0	38 15 0 to 35 10 0	180 2 6 to 180 5 0	181 2 6 to 181 5 0	$31\frac{7}{8}$	$31\frac{5}{8}$	90 1	7
26 0 0 to 25 5 0	27 5 0	38 5 0 to 35 5 0	180 15 0 to 181 0 0	181 15 0 to 182 0 0	$31\frac{13}{16}$	$31\frac{1}{2}$	90 1	8

about, but little actual business. The quotation is unaltered at about 5s. 6d. per lb.

ALUMINIUM.—English is rather easier at £92 10s. delivered. German material is offered at £85 f.o.b. Continent. There has been a fairly good demand latterly from the automobile trade.

NICKEL.—The price is again lower at £130 for home and export. Continental material is about the same price, but it is occasionally possible to pick up a cheap line owing to exchange fluctuations.

COBALT METAL.—Rather a dull market, at 11s. to 12s. per lb., according to quantity.

COBALT OXIDES.—There is a steady demand, with prices steady at 10s. per lb. for grey and 9s. for black. For a good order rather lower figures might be accepted.

PLATINUM.—Manufactured is quoted at £23 and sponge at about £20 per oz.

PALLADIUM.—Business is on a small scale. Sponge is quoted at £12 10s. and manufactured metal at £16 to £17 per oz.

QUICKSILVER.—Prices are rather lower, the spot quotation being about £11 17s. 6d. to £12 per bottle.

SELENIUM.—There is a good demand, and the current price of powder is about 7s. 8d. per lb.

TELLURIUM.—Steady at 40s. per lb.

MANGANESE ORE.—Indian grades are scarce, the bulk of the available material being delivered against contracts. Some sales were recently made around 1s. 3d. per unit c.i.f. Caucasian is nominal, without much offering, as the industry there has been badly hit by floods. Ordinary grades may be called 1s. 2¾d. and washed 1s. 3½d. to 1s. 4d. per unit.

CHROME ORE.—Prices are firm, Indian grades, basis 48 to 50%, being quoted at £4 5s. c.i.f. Continent and £4 10s. c.i.f. U.K. Supplies are short with a fairly active demand.

SULPHATE OF COPPER.—The present quotation is £26 per ton for either home or export business.

TUNGSTEN ORE.—Straits, 65%, 2% tin, is fetching about 13s. 9d. c.i.f., while 1½% tin realizes about 14s. to 14s. 3d. c.i.f. Spot material is priced at 14s. 6d. For Chinese ore, up to 15s. 2d. c.i.f. is asked.

MOLYBDENITE.—Business is dull and supplies are short; 85% MoS_2 is quoted at 47s. 6d. to 52s. 6d. per unit, c.i.f.

SILVER.—The market was rather depressed during the month, China, America, and the Continent being inclined to sell, while Indian support was not sufficient to maintain values. Spot bars opened the month at $33\frac{15}{16}$d. on November 1, advanced to $34\frac{1}{16}$d. on the 6th, and fell to $32\frac{1}{8}$d. by the 16th. A recovery to $32\frac{11}{16}$d. on the 18th was followed by a relapse to the low level of $31\frac{7}{8}$d. on the 28th, but the price closed the month slightly firmer at $32\frac{1}{8}$d. on the 30th.

GRAPHITE.—Business has remained dull, and 85 to 90% Madagascar is rather nominal at £12 per ton, c.i.f.

IRON AND STEEL.—There has been a still further decline in the American purchases of foundry grades of pig iron, and this has rather had the effect of easing down the Cleveland market, especially also as fuel is costing less money. Pig iron makers, however, have their books well filled, and substantial quantities have yet to be shipped to the United States, so that the position really calls for little anxiety. Cleveland No. 3 G.M.B. is now quoted at 92s. The market for steel-making iron has kept firm throughout the month. With costs cheaper, makers have been able to increase their output by blowing in further furnaces, and all this new production is being taken care of. The current price for East Coast mixed numbers is about 93s. to 93s. 6d. for either home or export. The recent placing of a fair number of new ship-building orders has given a fillip to the steel trade, and some decent plate orders have in consequence been placed. More also is doing in railway material, and hopes are entertained that the large railway schemes will come to pass, thereby temporarily assisting the iron and steel trades. Export buying generally has been quiet, but a feature of encouragement is the return of the Japanese market to British material, this market having for a long time bought from the United States.

STATISTICS

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Price of Gold per oz.
	Oz.	Oz.	Oz.	s. d.
November, 1921	688,183	16,053	704,236	102 0
December	664,935	16,912	681,847	95 6
Total, 1921	7,924,534	190,052	8,114,586	—
January, 1922 / February / March	594,788	44,940	639,728	95 6 / 92 6 / 94 0
April	493,402	17,936	511,338	92 0
May	612,702	17,083	629,786	92 0
June	658,032	17,665	675,697	92 6
July	713,068	17,567	730,635	92 0
August	734,438	18,052	752,490	92 0
September	728,597	18,492	747,089	93 0
October	759,702	18,457	778,159	92 0

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
August 31, 1921	169,908	14,446	1,207	184,661
September 30	171,912	14,244	1,219	187,375
October 31	175,331	13,936	1,223	190,490
November 30	176,419	13,465	1,217	191,092
December 31	177,836	13,280	1,224	192,340
March 31, 1922	124,169	11,155	1,204	136,528
April 30	138,277	11,385	1,232	150,894
May 31	155,425	11,525	1,219	168,169
June 30	170,464	12,117	1,211	183,792
July 31	172,886	12,371	1,211	186,468
August 31	175,054	12,270	1,219	188,543
September 30	174,565	12,000	1,234	187,799
October 31	175,129	11,495	1,218	187,842

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. Figures for yield include premium.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
October, 1921	2,041,581	34 4	24 9	9 7	981,597
November	2,007,617	34 6	24 9	9 9	978,931
December	1,954,057	31 11	24 11	7 0	683,565
Jan., 1922 / February / March	1,624,333	33 10	49 0	15 2*	1,233,033*
April	1,414,843	31 7	24 3	7 4	519,365
May	1,772,793	31 4	22 8	8 8	767,533
June	1,882,837	31 10	22 8	9 2	862,575
July	2,057,895	31 0	21 1	9 11	1,048,727
August	2,144,850	30 11	20 6	10 5	1,113,905
September	2,128,173	31 5	20 5	11 0	1,170,115

* Loss.

Production of Gold in Rhodesia.

	1920	1921	1922
	oz.	oz.	£
January	43,428	46,956	53,541
February	44,237	40,816	51,422
March	45,779	31,995	54,643
April	47,000	47,858	54,318
May	46,266	48,744	53,920
June	[illegible]	49,466	55,614
July	46,208	51,564	54,191
August	[illegible]	53,200	56,037
September	45,471	52,436	55,443
October	47,343	53,424	54,670
November	46,782	53,098	—
December	46,190	55,968	—
Total	552,498	591,525	543,799

Transvaal Gold Outputs.

	September Treated Tons	September Yield Oz.	October Treated Tons	October Yield Oz.
Aurora West	11,900	£14,487†	12,300	£15,290*
Brakpan	62,000	25,727	64,500	26,507
City Deep	83,500	35,638	98,500	41,157
Cons. Langlaagte	47,200	£57,127†	48,000	£59,768*
Cons. Main Reef	53,300	19,106	55,100	19,327
Crown Mines	216,000	68,052	221,000	69,287
D'rb'n Roodepoort Deep	30,700	10,603	34,000	11,026
East Rand P.M.	129,000	30,216	141,500	33,876
Ferreira Deep	34,700	9,985	33,300	10,253
Geduld	45,000	16,494	46,500	17,356
Geldenhuis Deep	54,181	13,588	54,200	13,883
Glynn's Lydenburg	4,285	£8,368‡	4,283	£8,305§
Goch	17,200	£17,197†	17,300	£17,013*
Government G.M. Areas	143,500	£291,485†	143,500	£294,011*
Kleinfontein	45,300	11,454	49,000	12,049
Knight Central	32,000	6,620	32,500	6,914
Langlaagte Estate	49,700	£74,590†	51,500	£77,915*
Luipaard's Vlei	19,692	£19,520†	21,250	£21,600*
Meyer & Charlton	15,000	£39,156†	15,600	£38,675*
Modderfontein, New	110,000	52,224	112,000	54,169
Modderfontein B	61,000	32,686	63,500	34,871
Modderfontein Deep	43,400	23,127	43,500	23,268
Modderfontein East	26,600	15,007	27,000	16,331
New Unified	11,500	£11,278†	11,400	£11,572*
Nourse	45,900	14,904	49,200	15,212
Primrose	21,700	£22,219†	22,400	£22,370*
Randfontein Central	163,000	£217,034†	167,500	£206,813*
Robinson	18,000	5,883	17,000	5,210
Robinson Deep	70,100	22,628	75,500	23,416
Rose Deep	53,700	13,181	55,000	13,251
Simmer & Jack	61,300	12,966	65,600	13,513
Springs	46,000	21,324	45,300	21,422
Sub-Nigel	10,000	5,733	9,800	6,206
Transvaal G.M. Estates	15,850	£24,752‡	16,440	£24,383§
Van Ryn	34,000	£45,327†	35,000	£49,209*
Van Ryn Deep	56,600	£132,557†	58,400	£133,203*
Village Deep	58,800	18,243	60,600	19,097
West Rand Consolidated	34,000	£44,119†	36,600	£44,121*
Witw'tersr'nd (Knights)	46,300	£55,208†	47,400	£54,160*
Witwatersrand Deep	43,500	13,147	46,510	13,126
Wolhuter	32,900	7,530	33,700	7,934

* £4 12s. per oz. § £4 9s. 6d. per oz. † £4 13s. per oz. ‡ £4 11s. per oz.

Rhodesian Gold Outputs.

	September Tons	September Oz.	October Tons	October Oz.
Cam & Motor	15,300	6,225	15,400	5,788
Falcon	16,312	3,045*	16,719	3,020‖
Gaika	—	—	—	—
Globe & Phœnix	6,399	6,049	6,401	6,398
Jumbo	1,400	508	1,475	517
London & Rhodesian	3,600	£3,478	3,228	£4,642
Lonely Reef	5,320	4,076	5,400	4,054
Planet-Arcturus	5,900	2,296	5,900	2,226
Rezende	6,100	3,470	6,100	3,002
Rhodesia G.M. & I.	—	—	—	—
Shamva	57,550	£36,773‡	58,750	£36,582‡
Transvaal&Rhodesian	1,560	£5,067†	1,660	£4,300†

* Also 292 tons copper. † At par. ‖ Also 291 tons copper.
§ Gold at £4 10s. per oz. ‡ Gold at £4 11s. per oz.

West African Gold Outputs.

	September Tons	September Oz.	October Tons	October Oz.
Abbontiakoon	7,700	£14,548*	7,600	£13,856*
Abosso	6,980	2,285	7,000	2,802
Ashanti Goldfields	7,612	6,436	8,017	6,398
Obbuassi	562	£1,065†	—	—
Prestea Block A	7,439	£15,033*	7,405	£14,194*
Taquah	2,400	1,247	2,321	1,410

* At par. † Including premium.

West Australian Gold Statistics.—Par Values.

	Reported for Export Oz.	Delivered to Mint Oz.	Total Oz.	Par Value £
February, 1922	926	41,194	42,120	178,913
March	180	42,842	43,022	182,745
April	1,237	45,157	46,394	197,068
May	271	39,454	39,725	168,740
June	136	49,158	49,294	209,386
July	366	42,774	43,140	183,247
August	1,051	48,638	49,689	211,064
September	—	46,398	46,398	197,085
October	216	49,092	49,308	209,446
November	153	46,401	45,554	197,747

Australian Gold Outputs.

	West Australia	Victoria	Queensland	New South Wales
	Oz.	Oz.	Oz.	£
January	38,181	4,411	448	11,855
February	42,121	8,063	1,200	12,325
March	43,022	11,717	1,069	12,960
April	46,394	4,186	6,219	6,589
May	39,725	19,089	7,636	13,100
June	49,294	12,058	12,181	6,784
July	43,140	9,966	6,906	4,907
August	49,690	8,456	8,077	5,285
September	46,398	6,672	9,349	12,053
October	49,308	—	—	—
November	45,554	—	—	—
December	—	—	—	—
Total	492,827	75,582	53,175	85,858

Australasian Gold Outputs.

	September		October	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	6,309	8,935‖	6,212	7,832
Blackwater (N.Z.)	3,670	9,385*	3,030	5,963*
Golden Horseshoe (W.A.)	9,012	5,460‡	9,240	5,569‡
Grt. Boulder Pro. (W.A.)	11,052	26,525‖	10,864	28,246‖
Hampton Celebr. (W.A.)	1,907	1,932‖	916	1,540‖
Ivanhoe (W.A.)	14,933	6,108‡	16,085	6,154‡
Lake View & Star (W.A.)	5,542	16,265*e*	—	—
Menzies Con. (W.A.)	1,800	3,642	1,680	3,279
Oroya Links (W.A.)	3,003	15,796‖†	3,047	17,015‖†
South Kalgurli (W.A.)	7,337	12,657‖	7,105	13,198‖
Waihi (N.Z.)	15,347	4,290‡ 36,805§	15,177	4,229‡ 36,272§
,, Grand Junc'n (N.Z.)	—	—	—	—

* Including premium ; † Including royalties ; ‡ Oz. gold ; § Oz. silver ; ‖ At par ; *e* two months to October 15.

Miscellaneous Gold and Silver Outputs.

	September		October	
	Tons	Value £	Tons	Value £
Brit. Plat. & Gold (C'lbia)	—	435*p*	—	347*p*
Colombian Mining (C'lbia)	—	—	4,750	6,635
El Oro (Mexico)	33,397	172,695†	32,500	168,387†
Esperanza (Mexico)	—	1,785*e*	—	1,837*e*
Frontino & Bolivia (C'lbia)	2,200	7,439	1,910	6,985
Keeley Silver (Canada)	—	83,000*s*	—	92,000*s*
Kirkland Lake (Ontario)	—	—	—	—
Mexican Corp. (Mexico)	244,565	823,849†*a*	91,008	102,155†
Mexico El Oro (Mexico)	13,199	299,050†	13,410	297,630†
Mining Corp. of Canada	8,051	173,290	—	—
New North-West (Yukon)	—	—	—	—
Oriental Cons. (Korea)	—	75,500†	—	73,000†
Ouro Preto (Brazil)	7,000	2,477‖	7,600	2,799
Plym'th Cons. (Calif'rnia)	6,000	7,160*	7,200	7,854*
St. John del Rey (Brazil)	—	38,000*	—	38,000*
Santa Gertrudis (Mexico)	40,234	27,837*e*	44,092	40,011*e*
Tomboy (Colorado)	18,000	75,000†	17,600	65,000†

*At par. † U.S. Dollars. ‡ Profit, gold and silver. ‖ Oz. gold. *p* Oz. platinum and gold. *s* Oz. silver. *e* Profit in dollars. *a* Three months to September 30.

Pato (Colombia): 14 days to October 31, $55,309 from 73,451 cu. yd.; 13 days to November 13, $21,377 from 68,326 cu. yd.

Gold Outputs, Kolar District, India.
During October, 1922.

	Tons Ore	Oz.	Tons Tailing	Oz.	Total Oz.
Balaghat	3,800	1,925	8,300	627	2,744
Champion Reef	11,626	3,233	26,776	1,080	4,313
Mysore	18,305	5,957	50,893	4,563	10,520
North Anantapur	—	—	1,300	120	150
Nundydroog	9,861	4,547	18,544	721	5,268
Ooregum	13,600	7,605	13,600	853	8,458

Total Gold Output for all India: February, 34,690 oz.; March, 35,607 oz.; April, 35,583 oz.; May, 36,120 oz.; June, 35,860 oz.; July, 35,670 oz.; August, 36,517 oz.

Base Metal Outputs.

		Sept.	October
British Broken Hill	Tons lead carb. ore	615‡	400*
	Tons lead conc.	3,680‡	2,450*
	Tons zinc conc.	3,260‡	2,200*
Broken Hill Prop.	Tons lead conc.	4,088*a*	1,737
	Tons zinc conc.	12,385*a*	6,432
Broken Hill South	Tons lead conc.	3,976	4,298
Burma Corporation	Tons refined lead	3,464	3,303
	Oz. refined silver	360,768	383,363
Electrolytic Zinc	Tons zinc	3,995*b*	1,975
Fremantle Trading	Tons lead	436	—
Mount Lyell	Tons copper	1,077§	294
	Oz. silver	22,526§	6,254
	Oz. gold	337§	100
Mount Morgan	Tons copper	956†	470
	Oz. gold	10,895†	5,602
North Broken Hill	Tons lead conc.	2,300	2,950
	Tons zinc conc.	2,050	2,580
Poderosa	Tons copper ore	550	450
Rhodesia Broken Hill	Tons lead	1,500	1,400
San Francisco Mexico	Tons lead conc.	1,920	1,820
	Tons shipping ore	—	—
Sulphide Corporation	Tons lead conc.	2,247	2,186
	Tons zinc conc.	3,938	3,534
Union Minière	Tons copper	3,510	3,788
Transvaal Silver	Tons silver-lead bullion	461	430
Zinc Corporation	Tons zinc conc.	8,795	7,710
	Tons lead conc.	684	755

* Four weeks to November 18. † Eight weeks to October 17.
‡ Six weeks to October 21. § Eight weeks to October 18.
a Eight weeks to October 11. *b* Eight weeks to October 18.

Imports of Ores, Metals, etc., into United Kingdom.

		September	October
Iron Ore	Tons	299,387	325,183
Manganese Ore	Tons	49,437	62,320
Iron and Steel	Tons	70,553	90,633
Copper and Iron Pyrites	Tons	27,148	37,290
Copper Ore, Matte, and Prec.	Tons	9,455	895
Copper Metal	Tons	6,939	7,347
Tin Concentrate	Tons	3,228	3,845
Tin Metal	Tons	1,733	968
Lead, Pig, and Sheet	Tons	17,030	20,268
Zinc (Spelter)	Tons	7,308	6,179
Zinc Sheets, etc.	Tons	943	1,217
Quicksilver	Lb.	90,251	367,049
Zinc Oxide	Tons	474	557
White Lead	Cwt.	9,835	10,044
Red and Orange Lead	Cwt.	3,629	3,707
Barytes, ground	Cwt.	63,237	25,109
Asbestos	Tons	1,221	1,043
Boron Minerals	Tons	2,729	319
Borax	Cwt.	3,003	5,621
Basic Slag	Tons	10,039	15,487
Phosphate of Lime	Tons	44,856	22,272
Mica	Tons	109	44
Sulphur	Tons	1,377	6,059
Nitrate of Soda	Cwt.	106,755	63,570
Potash Salts	Cwt.	385,789	612,153
Petroleum: Crude	Gallons	13,794,239	24,570,320
Lamp Oil	Gallons	5,549,537	18,001,651
Motor Spirit	Gallons	17,743,294	20,165,829
Lubricating Oil	Gallons	6,464,467	5,717,192
Gas Oil	Gallons	1,513,088	4,728,360
Fuel Oil	Gallons	26,268,789	13,573,005
Asphalt and Bitumen	Tons	12,247	17,731
Paraffin Wax	Cwt.	95,647	79,576
Turpentine	Cwt.	25,921	64,096

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	August	September	October
	Tons	Tons	Tons
Nigeria:			
Bisichi	40	34½	34
Ex-Lands	30	30	50
Filani	2¾	3	2
Gold Coast Consolidated	—	—	—
Gurum River	8	9	8
Jantar		—	22¾
Jos	12¼	10½	14¾
Kaduna	3¼	4¼	3¼
Kaduna Prospectors	3½	7⅜	6
Keffi Consolidated	20	20	20
Lower Bisichi	10½	12¾	13¼
Mongu	30	30	40
Naraguta	50	50	48
Naraguta Extended	27	27	20
Nigerian Consolidated	9	15	14¾
N.N. Bauchi	60	69	62
Rayfield	40	40	40
Ropp	102	108	109
Rukuba	2½	3	3
South Bukeru	5	7	10
Tin Fields	8	8	10
Yarde Kerri	3	4	4
Federated Malay States:			
Chenderiang	—	88*	—
Gopeng	53½	65½	71⅓
Idris Hydraulic	17¼	19½	16½
Ipoh	16	21¾	20
Kamunting	—	106*	—
Kinta	30	30	30
Lahat	32¾	32½	33¾
Malayan Tin	86¾	95¼	92¼
Pahang	205	180	169
Pengkalen	12	—	15
Rambutan	18	18	18
Sungei Besi	54	54	55
Tekka	31	39	42
Tekka-Taiping	9½	20	39
Tronoh	71	67½	66
Other Countries:			
Aramayo Mines (Bolivia)	200	211	214
Berenguela (Bolivia)	36	37	37
Briseis (Tasmania)	—	23	30
Deebook Ronpibon (Siam)	30	27	24
Leeuwpoort (Transvaal)	—	—	—
Macreedy (Swaziland)	—	—	—
Renong (Siam)	68	60½	65¼
Rooiberg Minerals (Transvaal)	—	—	—
Siamese Tin (Siam)	90½	81½	109
Southern Perak	—	—	29½
Tongkah Harbour (Siam)	83	91	110
Zaaiplaats (Transvaal)	—	—	—

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note.—These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1917	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons	Tons
January	667	678	613	547	438	473
February	646	668	623	477	370	412
March	655	707	606	505	445	456
April	[illegible]	584	546	467	394	434
May	[illegible]	525	483	383	337	485
June	[illegible]	492	484	435	423	509
July	[illegible]	545	481	484	494	467
August	551	[illegible]	616	447	477	467
September	538	[illegible]	561	528	595	492
October	578	491	625	628	546	487
November	621	[illegible]	536	544	564	—
December	655	518	511	577	555	—
Total	6,927	6,771	6,685	6,022	5,618	4,882

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1918	1919	1920	1921	1922
	Tons	Tons	Tons	Tons	Tons
January	3,035	3,765	4,265	3,298	3,143
February	3,197	2,734	3,014	3,111	2,572
March	2,609	2,819	2,770	2,190	2,839
April	3,308	2,858	2,606	2,692	2,896
May	3,332	3,407	2,741	2,884	3,104
June	3,070	2,877	2,940	2,752	2,909
July	3,373	3,756	2,824	2,734	3,086
August	3,259	2,956	2,786	3,051	3,001
September	3,157	3,161	2,734	2,338	2,890
October	2,870	3,221	2,837	3,161	2,837
November	3,132	2,972	2,573	2,800	—
December	3,022	2,409	2,838	3,435	—
	37,370	36,935	34,928	34,446	29,277

Stocks of Tin.

Reported by A. Strauss & Co. Long Tons.

	Sept. 30	Oct. 31	Nov. 30
Straits and Australian Spot	2,714	2,234	1,766
Ditto, Landing and in Transit	25	100	535
Other Standard, Spot and Landing	4,383	3,901	3,611
Straits, Afloat	455	370	670
Australian, Afloat	125	125	105
Banca, in Holland	2,573	2,453	2,395
Ditto, Afloat	891	50	1,552
Billiton, Spot	14	—	—
Billiton, Afloat	—	—	—
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	450	800	1,200
Total Afloat for United States	7,622	7,083	7,698
Stock in America	1,236	2,859	2,699
Total	20,488	19,975	22,131

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long Tons.

	Sept.	Oct.	Nov.
Shipments from:			
Straits to U.K.	250	375	680
Straits to America	3,350	4,450	4,265
Straits to Continent	450	825	1,200
Straits to other places	250	150	125
Australia to U.K.	150	128	25
U.K. to America	75	350	—
Imports of Bolivian Tin into Europe	1,394	2,812	1,787
Supply:			
Straits	4,050	5,650	6,145
Australian	150	128	25
Billiton	—	—	—
Banca	1,760	360	1,870
Standard	928	1,686	1,774
Total	6,888	7,824	9,814
Consumption:			
U.K. Deliveries	1,770	1,315	1,851
Dutch ,,	548	634	188
American ,,	5,050	5,603	4,812
Straits, Banca & Billiton, Continental Ports, etc.	785	785	807
Total	8,153	8,337	7,658

Imports and Exports of Gold and Silver.

During October, 1922.

		Imports	Exports.
Gold:	Unrefined Bullion £	454,510	—
	Refined Bars ,,	2,938,467	6,394,720
	Coin ,,	3,391	248,311
Silver:	Unrefined Bullion oz.	206,903	—
	Refined Bars ,,	770,543	6,196,224
	Coin £	274,917	189,900

Outputs Reported by Oil-producing Companies. In Tons.

	August	Sept.	October
Anglo-Egyptian	19,195	17,082	12,320
Anglo-Texas	1,784	1,530	1,564
Apex Trinidad	11,900	11,000	9,700
Astra Romana	33,210	32,365	—
British Burmah	9,989	9,390	9,289
Caltex	10,484	4,258	—
Dacia Romana	1,107	278	286
Kern River	13,372	13,197	15,439
Lobitos	9,371	9,092	9,481
Phœnix	3,250	3,050	3,300
Romana Americana	16,890	15,627	15,553
Roumanian Consolidated	1,504	1,751	1,686
Santa Maria	1,453	—	1,628
Steaua Romana	20,680	21,632	19,962
Trinidad Leaseholds	9,500	10,200	11,250
United of Trinidad	5,376	4,224	5,194

Quotations of Oil Companies' Shares.

Denomination of Shares £1 unless otherwise noted.

	Nov. 6, 1922 £	s.	d.	Dec. 7, 1922 £	s.	d.
Anglo-American	4	10	0	4	5	0
Anglo-Egyptian B.	1	7	6	1	6	3
Anglo-Persian 1st Pref.	1	3	6	1	3	6
Apex Trinidad	2	3	9	2	0	0
British Borneo (10s.)		11	3		10	0
British Burmah (8s.)		10	0		10	0
Burmah Oil	5	5	0	5	0	0
Caltex ($1)		1	6		1	3
Dacia Romano		11	3		12	6
Kern River, Cal. (10s.)		19	0		17	9
Lobitos, Peru	5	10	0	5	12	6
Mexican Eagle, Ord. ($5)	2	12	6	2	6	3
,, ,, Pref. ($5)	2	10	0	2	6	3
North Caucasian (10s.)		13	9		12	6
Phœnix, Roumania	1	7	0	1	3	9
Roumanian Consolidated		13	6		12	3
Royal Dutch (100 gulden)	36	10	0	35	0	0
Scottish American		1	0		1	0
Shell Transport, Ord.	4	2	6	3	18	9
,, ,, Pref. (£10)	9	10	0	9	5	0
Trinidad Central	1	13	9	1	10	0
Trinidad Leaseholds	1	3	9	1	1	3
United British of Trinidad		8	9		6	3
Ural Caspian		12	0		16	0
Uroz Oilfields (10s.)		8	0		7	0

Petroleum Products Prices. December 8.

Refined Petroleum: Water white, 1s. per gallon; standard white, 11d. per gallon; in barrels 3d. per gallon extra.

Motor Spirit: In bulk: Aviation spirit, 2s. 1d. per gallon; No. 1, 1s. 9d. per gallon; No. 2, 1s. 7d. per gallon.

Fuel Oil: Furnace fuel oil, £3 5s.; Diesel oil, £4 2s. 6d. per ton.

American Oils: Best Pennsylvania crude at wells, $3·00 per barrel. Refined standard white for export in bulk, 7·50 cents per U.S. gallon; in barrels 13·75 cents. Refined water white for export in bulk, 8·50 cents per U.S. gallon; in barrels 14·75 cents.

Dividends Declared by Mining Companies.

During month ended December 10.

Company	Par Value of Shares	Amount of Dividend
Apex Trinidad Oilfields	£1	10% less tax.
Berenguela Tin	4s.	5% less tax.
Cassel Cyanide	5s.	6d. less tax.
Central Mining and Investment	£8	6s. tax paid.
Deebook Dredging	£1	6d.*
Globe and Phœnix	5s.	1s. tax paid.
Gold Mines Investment	10s.	1s. less tax.
Great Boulder Perseverance	£1	2d.*
Kramat Pulai	£1	1s. less tax.
Lahat Mines	£1	6d. less tax.
Mexico of El Oro	£1	7s. 6d. tax paid
Mount Lyell	£1	1s. less tax.
Oroville Dredging	£1	9d. less tax.
Pahang Consolidated	Pref.	3½% less tax.
Rambutan	£1	8d. less tax
Sulphide Corporation	Pref. £1	10% less tax.
	Ord. 15s.	5% less tax.
Sungei Besi	£1	1s. less tax.
Tekka	£1	4½d. less tax
Transvaal and Rhodesian Estates	3s.	2d. tax paid.
Tronoh	£1	1s. less tax.

* Return of Capital.

PRICES OF CHEMICALS. December 6.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	0	0
,, 80%	,,	2	0	0
,, Glacial	per ton	65	0	0
Alum	,,	13	10	0
Alumina, Sulphate	,,	10	10	0
Ammonia, Anhydrous	per lb.		1	6
,, 0·880 solution	per ton	23	0	0
,, Carbonate	per lb.			4
,, Chloride, grey	per ton	32	0	0
,, ,, pure	per cwt.	3	3	0
,, Nitrate	per ton	40	0	0
,, Phosphate	,,	65	0	0
,, Sulphate	,,	16	0	0
Antimony, Tartar Emetic	per lb.		1	5
,, Sulphide, Golden	,,		1	3
Arsenic, White	per ton	65	0	0
Barium Carbonate	,,	6	0	0
,, Chlorate	per lb.			6
,, Chloride	per ton	20	0	0
,, Sulphate	,,	7	0	0
Benzol, 90%	per gal.		1	10
Bisulphide of Carbon	per ton	48	0	0
Bleaching Powder, 35% Cl.	,,	13	0	0
,, Liquor, 7%	,,	4	10	0
Borax	,,	28	0	0
Boric Acid Crystals	,,	55	0	0
Calcium Chloride	,,	6	0	0
Carbolic Acid, crude 60%	per gal.		2	0
,, ,, crystallized, 40°	per lb.			6
China Clay (at Runcorn)	per ton	4	10	0
Citric Acid	per lb.		1	9
Copper Sulphate	per ton	26	0	0
Cyanide of Sodium, 100%	per lb.			9½
Hydrofluoric Acid	,,			7½
Iodine	per oz.		1	0
Iron, Nitrate	per ton	6	10	0
,, Sulphate	,,	2	10	0
Lead, Acetate, white	,,	38	0	0
,, Nitrate	,,	43	0	0
,, Oxide, Litharge	,,	35	0	0
,, White	,,	42	0	0
Lime, Acetate, brown	,,	8	5	0
,, ,, grey 80%	,,	14	10	0
Magnesite, Calcined	,,	11	0	0
Magnesium, Chloride	,,	8	0	0
,, Sulphate	,,	8	0	0
Methylated Spirit 64° Industrial	per gal.		2	8
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per lb.			7
Phosphoric Acid	per ton	32	0	0
Potassium Bichromate	per lb.			6½
,, Carbonate	per ton	29	0	0
,, Chlorate	per lb.			4
,, Chloride 80%	per ton	11	0	0
,, Hydrate (Caustic) 90%	,,	28	0	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			8
,, Prussiate, Yellow	,,		1	5
,, ,, Red	,,		4	3
,, Sulphate, 90%	per ton	14	0	0
Sodium Acetate	per ton	24	0	0
,, Arsenate, 45%	,,	45	0	0
,, Bicarbonate	,,	11	0	0
,, Bichromate	per lb.			5
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			3
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	11	0	0
,, Nitrate, 96%	,,	13	0	0
,, Phosphate	,,	16	0	0
,, Prussiate	per lb.			11
,, Silicate	per ton	11	5	0
,, Sulphate (Salt-cake)	,,	4	0	0
,, ,, (Glauber's Salts)	,,	4	10	0
,, Sulphide	,,	18	0	0
,, Sulphite	,,	10	0	0
Sulphur, Roll	,,	8	10	0
,, Flowers	,,	9	0	0
Sulphuric Acid, Fuming, 65°	,,	24	0	0
,, ,, free from Arsenic, 144°	,,	4	10	0
Superphosphate of Lime, 30%	,,	3	15	[illegible]
Tartaric Acid	per lb.		1	[illegible]
Turpentine	per cwt.	5	6	[illegible]
Tin Crystals	per lb.		1	3
Titanous Chloride	,,		1	[illegible]
Zinc Chloride	per ton	20	0	0
Zinc Oxide	,,	[illegible]	0	0
Zinc Sulphate	,,	14	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

	Dec. 6, 1921 £	s.	d.	Dec. 7, 1922 £	s.	d.
RAND:						
Anglo-American Corporation		18	9	1	3	9
Brakpan	2	10	0	2	18	9
Central Mining (£8)	6	5	0	9	5	0
City & Suburban (£4)		2	9		3	0
City Deep	2	5	0	2	17	6
Consolidated Gold Fields		13	9		17	6
Consolidated Langlaagte		13	9		17	3
Consolidated Main Reef		9	6		13	3
Consolidated Mines Selection (10s.)		14	0		16	0
Crown Mines (10s.)	1	17	6	3	2	6
Daggafontein		2	6		3	6
Durban Roodepoort Deep		4	6		14	6
East Rand Proprietary		5	0		8	6
Ferreira Deep		7	6		9	3
Geduld	2	6	3	3	2	6
Geldenhuis Deep		5	0		6	6
Government Gold Mining Areas	4	2	6	5	7	6
Johannesburg Consolidated	1	1	6	1	10	6
Kleinfontein		5	3		7	9
Knight Central		4	6		4	9
Langlaagte Estate		11	6	1	3	6
Luipaards Vlei		3	0		3	9
Meyer & Charlton	4	0	0	4	0	0
Modderfontein, New (10s.)	3	15	0	4	6	3
Modderfontein B (5s.)	1	7	6	1	13	9
Modderfontein Deep (5s.)	2	2	6	2	7	6
Modderfontein East		7	6		7	6
New State Areas	1	1	3	1	13	9
Nourse		8	6		17	0
Rand Mines (5s.)	2	2	6	3	2	6
Randfontein Central		10	0		16	6
Robinson (£5)		9	0		10	6
Robinson Deep A (1s.)		7	6	1	16	3
Rose Deep		13	6		14	6
Simmer & Jack		2	9		4	0
Springs	1	18	9	2	8	9
Sub-Nigel		11	3		10	6
Union Corporation (12s. 6d.)		14	6	1	3	6
Van Ryn		12	0		18	6
Van Ryn Deep	3	8	9	3	12	6
Village Deep		8	6		17	6
West Springs		11	3		17	0
Witwatersrand (Knight's)		12	6		19	0
Witwatersrand Deep		8	3		16	3
Wolhuter		4	0		3	0
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		8	0		15	0
Transvaal Gold Mining Estates		7	6		10	6
DIAMONDS IN SOUTH AFRICA:						
Consolidated of S.W.A.		—		1	1	6
De Beers Deferred (£2 10s.)	9	10	0	13	0	0
Jagersfontein	2	2	6	3	15	0
Premier Deferred (2s. 6d.)	4	5	0	6	5	0
RHODESIA:						
Cam & Motor		9	6	1	6	0
Chartered British South Africa		11	6		11	0
Falcon		4	3		5	0
Gaika		10	0		11	0
Globe & Phœnix (5s.)		12	6		12	0
Gold Fields Rhodesian (10s.)		5	6		6	3
Lonely Reef	2	3	9	1	17	6
Rezende	3	5	0	2	17	6
Shamva	1	10	0	1	8	9
WEST AFRICA:						
Abbontiakoon (10s.)		2	0		2	0
Abosso		6	6		9	0
Ashanti (4s.)		14	6		12	9
Prestea Block A		1	6		1	0
Taquah		8	6		5	6
WEST AUSTRALIA:						
Associated Gold Mines		3	3		7	0
Associated Northern Blocks		2	0		2	0
Bullfinch (5s.)		1	0		1	0
Golden Horse-Shoe (£5)		12	6		15	0
Great Boulder Proprietary (2s.)		5	6		4	0
Great Fingall (10s.)		1	0			9
Hampton Celebration		2	6		1	6
Hampton Properties		4	3		6	9
Ivanhoe (£5)		17	6		16	3
Lake View Investment (10s.)		7	0		10	3
Lake View & Star (4s.)		2	0		1	6
Oroya Links (5s.)		1	3		1	0
Sons of Gwalia		3	6		4	6
South Kalgurli		7	6		9	9
GOLD, SILVER, *cont.*						
NEW ZEALAND:						
Blackwater		2	6		6	3
Waihi	1	1	3	1	13	9
Waihi Grand Junction		7	6		11	3
AMERICA:						
British Platinum, Colombia		10	0		10	6
Camp Bird, Colorado		3	0		3	9
El Oro, Mexico		8	3		8	6
Esperanza, Mexico		15	0		10	0
Frontino & Bolivia, Colombia		5	0		10	0
Kirkland Lake, Ontario		11	0		10	6
Le Roi No. 2 (£5), British Columbia		2	6		1	6
Mexican Corporation, Mexico		—			6	6
Mexico Mines of El Oro, Mexico	3	10	0	4	15	0
Nechi (Pref. 10s.), Colombia		4	0		3	9
Oroville Dredging, Colombia	1	1	3	1	0	0
Ouro Preto, Brazil		15	0		14	6
Plymouth Consolidated, California		3	9		5	0
St. John del Rey, Brazil		16	0		18	9
Santa Gertrudis, Mexico		5	6		6	6
Tomboy, Colorado		5	0		5	0
RUSSIA:						
Lena Goldfields		5	0		10	0
Orsk Priority		5	0		5	0
INDIA:						
Balaghat (10s.)		7	3		9	3
Champion Reef (2s. 6d.)		1	6		6	0
Mysore (10s.)		10	9		11	3
North Anantapur		2	6		2	6
Nundydroog (10s.)		7	9		7	9
Ooregum (10s.)		10	9		15	0

COPPER:

	Dec. 6, 1921 £	s.	d.	Dec. 7, 1922 £	s.	d.
Arizona Copper (5s.), Arizona		17	6	1	0	0
Cape Copper (£2), Cape and India		10	0		10	0
Hampden Cloncurry, Queensland		5	0		5	0
Mason & Barry, Portugal	2	15	0	2	10	0
Messina (5s.), Transvaal		3	0		3	0
Mount Elliott (£5), Queensland		10	0		8	9
Mount Lyell, Tasmania		13	9	1	0	9
Mount Morgan, Queensland		13	6		11	6
Namaqua (£2), Cape Province		17	6	1	10	0
Rio Tinto (£5), Spain	26	15	0	29	0	0
Russo-Asiatic Consd., Russia		7	0		9	6
Sissert, Russia		5	0		4	0
Spassky, Russia		7	6		10	0
Tanganyika, Congo and Ehodesia		18	9		15	6

LEAD-ZINC:

	Dec. 6, 1921 £	s.	d.	Dec. 7, 1922 £	s.	d.
BROKEN HILL:						
Amalgamated Zinc		15	0	1	2	6
British Broken Hill	1	6	3	1	12	6
Broken Hill Proprietary	1	8	9	1	11	3
Broken Hill Block 10 (£10)		12	6		6	3
Broken Hill North	1	12	6	2	7	6
Broken Hill South	1	8	9	2	7	6
Electrolytic Zinc Pref.		—		1	7	0
Sulphide Corporation (15s.)		10	3		14	0
Zinc Corporation (10s.)		11	0		13	6
ASIA:						
Burma Corporation (10 rupees)		5	6		7	0
RHODESIA:						
Rhodesia Broken Hill (5s.)		5	3		6	0

TIN:

	Dec. 6, 1921 £	s.	d.	Dec. 7, 1922 £	s.	d.
Aramayo Mines, Bolivia	1	15	0	3	0	0
Bisichi (10s.), Nigeria		5	9		6	6
Briseis, Tasmania		3	0		4	6
Chenderiang, Malay		10	0		5	0
Dolcoath, Cornwall			9			6
East Pool (5s.), Cornwall		3	0		3	0
Ex-Lands Nigeria (2s.), Nigeria		1	6		2	3
Geevor (10s.), Cornwall		2	6		5	3
Gopeng, Malay	1	13	9	1	15	0
Ipoh Dredging, Malay		7	6		11	6
Kamunting, Malay	1	0	0	1	0	0
Kinta, Malay	1	12	6	1	12	6
Lahat, Malay		10	0		8	9
Malayan Tin Dredging, Malay	1	1	3	1	7	6
Mongu (10s.), Nigeria		12	6		11	0
Naraguta, Nigeria		13	0		13	9
N. N. Bauchi, Nigeria (10s.)		2	0		2	0
Pahang Consolidated (5s.), Malay		5	6		7	0
Rayfield, Nigeria		4	0		2	9
Renong Dredging, Siam	1	3	9	1	3	9
Ropp (4s.), Nigeria		5	9		7	3
Siamese Tin, Siam	1	13	9	2	3	9
South Crofty, (5s.) Cornwall		3	3		5	6
Tehidy Minerals, Cornwall		5	0		7	6
Tekka, Malay		17	6		17	6
Tekka-Taiping, Malay	1	0	0		17	6
Tronoh, Malay	1	1	3	1	8	9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts o the yearly reports of mining companies.

THE SPONTANEOUS IGNITION OF PYRITES

At the meeting of the Institution of Mining Engineers held in London on November 16 and 17, A. O. Brown presented a paper entitled "Mineral Fires in the Huelva Pyrites Mines, Spain." This paper constituted the Fifth Report to the Institution's Committee on the Control of Atmospheric Conditions in Hot and Deep Mines.

The ore mined in the Huelva district is mainly an intimate mixture of iron pyrites and chalcopyrite. Near the surface there is not much oxide or carbonate, but below the gossan there is usually a considerable zone of secondary enrichment, in which chalcocite is the chief copper mineral. There are also zones, chiefly in depth, where there is a greater development of chalcopyrite, which is frequently accompanied by blende and galena.

As a general rule, fires do not break out in hard primary ore that has suffered no movement. They occur either in the zone of secondary enrichment, where the softer and more easily oxidized chalcocite occurs, or in primary ore of unusual softness that has moved. Spontaneous combustion caused by oxidation is the probable cause of all the true mineral fires. In the enriched zone the chalcocite mineral is much more oxidizable than the ore of the deeper primary zone. In the latter zone fires do not occur unless the movement or fall of some softer portion has resulted in exposing large surfaces to oxidation in the presence of a limited air-supply. The heat generated by a fall or movement of mineral will of itself cause a fire. This heat is small compared with that of oxidation, and it is only by exposing larger surfaces to oxidation that a fall of mineral conduces to the outbreak of a fire. In the case of fires associated with a fall of mineral the outbreak is not a sudden one, as would be the case if the fire were the direct result of the fall. The fire breaks out several weeks after the fall, showing that it has been caused by chemical action, assisted by the conditions produced by the fall.

The sequence of events is probably as follows :—The mineral is broken up a great deal by the fall, and consequently considerably more surface is exposed. Air naturally fills these spaces, and slight oxidation and heating take place. There is, however, no flow of air to take away the heat generated ; consequently, it accumulates and the chemical action increases. As the air becomes heated it expands, and there is a small flow set up through the broken mineral. This is sufficient to renew the air and bring all the oxygen required to continue the chemical action, but not sufficient to take away the heat generated. The temperature continues to increase, and with the increase in temperature there is an increase in chemical action. If no timber is present, the temperature will gradually increase till sulphur dioxide is given off ; and the fire will steadily increase and spread unless something is done to stop it. If, however, timber is present, the temperature becomes high enough to ignite the timber. Then, if a sufficient supply of air is available, there is what is called a "sudden" outbreak of a pyrites fire. It often happens, however, that there is not sufficient air in the crushed mineral to permit the timber to ignite ; in which case carbon monoxide may be given off, and the timber may be simply converted into charcoal. If during this process work is being done in the fire area, and the extremely hot timber is suddenly exposed, it will almost at once burst into flame. This may happen during the operation of driving under a block of fallen or heated mineral if some mineral falls away, due, say, to a broken head-board. The mineral above, which is possibly nearly red-hot, settles a little and permits air to enter, with the result that the adjoining timber at once breaks into fire. Naturally, falls of mineral occur in the zones of mineral that are softer and more porous, and are therefore, in themselves, more liable to oxidation.

As confirmation of combustion being caused in the mineral by oxidation unassisted by timber or friction, it may be pointed out that fires occur also in the heaps of broken mineral laid down for washing. Air and water are used for the working of these heaps and the control of their temperatures, and in hot weather, in the absence of water, fires sometimes break out. Further, it has been observed that lump-heaps are much more likely to heat up than heaps of fines. This doubtless is due to the greater air-spaces in a lump-heap than in a heap of fines.

Once a fire has started, extinction becomes a difficult matter ; in fact, fires are rarely completely extinguished, especially in the neighbourhood of old workings where timber and blocks of ore have usually been abandoned among loose filling. No general treatment can be given. In some cases flooding has been resorted to, but this is not always convenient. In most cases cooling by means of the introduction of large volumes of low-pressure air is advised, as well as the mining out, as soon as possible, of the mineral in the troublesome area.

When the seat of the fire is in the upper part of the mine, it is impossible to flood it without at the same time flooding the lower workings, with consequent temporary abandonment of the whole exploitation. The difficulties of reopening the mine after flooding are great, as the workings have naturally become ruined, and it is impossible to reopen and ventilate the fired zone with any speed. Time is thus given for the heat to regenerate, and if any timber is unburnt, fire is apt to break out again. In breaking into an old working, after flooding, charcoal has been seen to glow in contact with the fresh air. The rapid regenera-

tion of heat results also in the desiccation of the salts formed on the floors of the drives, as well as on the faces of the mineral and in the interstices of filling. From a working point of view this is a greater nuisance, during the reopening of the zone, than the actual heat or even the sulphurous acid gas.

Although, however, the use of water has these disadvantages, it has, also, the benefit of being quicker in its action than air. Wherever it is possible for the water to get at it, the fire will be at once put out, and no more fumes of sulphur dioxide will be generated. This gas cannot be formed until the temperature of the mineral is appreciably above 100° C. The mineral cannot acquire a heat exceeding 100° C. while any water is present, as all heat available is used in converting the water into steam at the same temperature. By keeping the mineral damp, therefore, a steamy oppressive atmosphere may be produced, but there can neither be fire nor sulphur-dioxide fumes under these circumstances.

In using water it is best to put on a large volume for a short time rather than a small volume for a longer time. The smaller amount will come on to the hot mineral, carrying a large amount of soluble matter, and will be dried off by the heat, thus closing the small channels and forming a crust over the worst part of the fire. This crust acts as a very effective roof, and prevents any water from reaching the burning mineral, with the result that the fire continues just as if no water were being put on. On the other hand, a large volume put on the first time will wash all sulphates before it, so diluting the solution that the fire cannot dry up the coming stream. In this way the mineral is given such a general cooling-down that it often takes quite a long time before the fire again gives trouble. Sometimes the water causes mineral to fall, and after the water is cut off this sets almost like concrete ; as most of the air-spaces are closed with sulphates, further oxidation and generation of heat are prevented.

The object aimed at in this method of dealing with a fire is to pass a large volume of air through the burning mass so as to cool it. If sufficient air can be passed, this will always be satisfactory ; but it is sometimes impossible to pass enough air, and if much less than the required amount is forced through, the only result will be to increase the fire. When fire breaks out, a temporary stopping (a brick or stone wall) is erected between the fire zone and the unfired mineral. By means of air from a fan giving a ½ in. water-gauge the fumes are driven forward as far as possible. Another temporary stopping is then erected, and the ventilation-pipe is carried forward. In this way it is possible to cool the mineral either by air or by water, as the circumstances may require ; in either case the best procedure is to start, as soon as possible, to work out the mineral in the troublesome area. If sufficient air can be got through to keep the mineral cool, no more is required. The introduction of oxygen may cause temporarily a renewed outbreak, but in the absence of timber the effects can be only very limited, and steady ventilation soon disperses the heat. Compressed air is not recommended, as its volume is small and the cost high. If used, it should be combined with a Körting air-injector placed at the nearest fresh-air point underground. This should deliver the air into a large pipe (12 in. in diameter) for carrying the air to a distance of some 8 metres from the face. For the supply of air a fan is preferred to a blower. If the face is comparatively airtight, an excessive load will be put on a blower, and probably the temporary stopping will be blown out or made to leak. On the other hand, if there is a large crack a blower will not keep up a sufficient supply to drive back the fumes effectively. A fan, being governed by its revolutions and maintaining the required pressure, meets both cases.

BURMA CORPORATION METALLURGY

The report of the Burma Corporation for 1921 contains a detailed statement relating to concentration and metallurgy by P. E. Marmion, who was appointed general manager in September of that year. We quote from his remarks at some length in the following paragraphs.

At the beginning of 1921 several units of plant in the two concentrating sections were incomplete and did not come into operation until a later date. No. 1 section of the mill did not operate as a gravity concentration unit until January 15, having been used previously as a dry-crushing unit to crush high-grade ore for the smelters. In March, the Deister table units were started with the object of producing a zinc concentrate of suitable grade for shipment. In April, the slime-flotation plant was put into operation, thus completing the mill as far as was then intended, and permitting it to be run on a definite flow-sheet. No change of any note was made to the flow-sheet until October, when it was decided, for the reason given later, to decrease the content of the lead concentrates from 48% to 44% by cutting in that portion of the zinc concentrate containing the highest lead and silver values. With this change, the secondary tube-mills were shut down. The effect of the change was to increase the recovery of lead and silver in the products available for the smelter, thereby increasing the immediate financial return, and to decrease the tonnage of zinc concentrate which was being stacked for realization at some future date. The capacity of the mill was also increased, with a consequent reduction in the cost per ton milled. During the period March to August, the total tonnage and assay value of zinc concentrate recovered was 3,800 tons assaying 11·6% lead, 43·1% zinc, and 17·4 oz. silver. As the high cost of transport from Namtu to Europe, together with the high returning charges prevailing at European spelter works, did not offer sufficient prospect of being able to ship zinc concentrates of the grade produced at any appreciable profit at current spelter prices, it was decided, in view of the large amount of silver and lead they contained, to discontinue their production for the time being at least, and to exert every effort toward obtaining the maximum possible recovery of lead and silver in such products as the smelter could conveniently handle. The production of zinc concentrates was therefore stopped on November 24, and the flow-sheet of the mill was altered and simplified accordingly. The effect of this change was an immediate increase in the recovery of lead and silver in the mill products to, approximately, 92% in each case.

From the above brief outline of operations it will be observed that work at the mill throughout the year was, more or less, of an experimental nature, and a definite flow-sheet, under prevailing conditions and metal prices, was not established until the end of the year. This flow-sheet will be modified and adjusted in detail to meet local operating conditions both at the smelter and the mill, but, in general, it will remain in effect till transport costs, metal prices, and the other factors which determine the financial result of the metallurgical policy, dictate a change.

The tonnage and grade of ore received during 1921 at the mill ore-bins was as follows :—

	Tons.	Ag. Oz.	Pb. %.	Zn. %.
High-Grade Ore	24,165	33·7	35·9	21·5
Concentrating Ore.....	115,046	31·0	32·4	21·0
Dump Ore............	19,582	17·6	21·1	13·0
Total............	158,795	29·7	31·5	20·1

Nos. 1 and 2 sections of the mill operated as concentrating units, and No. 3 section, which is complete only as far as the rolls, operated as a dry-crushing unit. In addition to the ore and concentrates, the concentrating sections of the mill re-treated 2,000 tons of jig tailings stacked from the previous year's operations. The tonnage, assay value, and recoveries of the products from the treatment of this tonnage were as follows :—

	Tons.	Ag. Oz.	Pb. %.	Zn. %.
Lead Concentrates.......	69,517	40·6	46·9	20·2
Flotation Concentrates ...	7,389	52·6	48·8	16·0
High-grade Slime........	5,108	34·2	35·6	17·3
Low-grade Slime	9,781	24·2	22·7	18·6
Total Leady Products....	91,796	39·5	43·9	19·5
Zinc Concentrates........	4,562	17·1	11·4	43·1
Mill Tailing..............	38,725	8·1	6·9	16·0
Flotation Tailing........	14,640	6·9	7·3	16·5
Total...............	149,723	27·5	29·7	19·1

The slime-flotation plant was started up on April 18, and has worked continuously thereafter. The process consists of a preferential flotation of the lead in an alkaline circuit. It has proved simple of operation and is well suited to the class of labour available, and it is also possible to obtain a zinc float from the de-leaded tailing in the same alkaline circuit. The percentage of oxidized dump ore in the tonnage milled was approximately 12·48, and this provided for the slime-flotation plant a feed high in oxidized lead and colloidal matter, the combined effect of which was to lower the recovery of silver and lead and increase the consumption of the alkaline reagent.

The results accomplished are shown in the following statement :—

	Tons.	Ag. Oz.	Pb. %.	Zn. %.
Feed................	22,029	21·5	20·8	16·6
Concentrate	7,389	52·6	48·8	16·0
Tailing................	14,640	6·9	7·3	16·5

The combined recovery of the total lead content of the feed was 78·59%, and was made up of a recovery of 88·94% on the unoxidized lead sulphide portion of the feed and a recovery of only 25·04% on the oxidized portion.

The following products were railed to the smelter :

	Tons.	Ag. Oz.	Pb. %.	Zn. %.
Lead Concentrates.....	69,690	39·7	46·2	20·4
Flotation Concentrates..	6,219	53·2	48·5	16·5
High-Grade Slime	5,614	36·9	36·0	18·0
Low-Grade Slime......	272	23·7	22·1	16·7
Total Lead Products	81,797	40·5	45·7	19·9
Accumulated Dam Slime	5,053	39·4	35·6	18·9
Dry-Crushed Ore......	13,446	32·1	34·6	20·0
Total.............	100,297	39·2	43·7	20·0

Toward the end of the year a new Dorr thickener was added to the slime-overflow section to increase the recovery of slime and to clean the return mill water. The addition of a further thickener is contemplated. An elevator has been installed at the outlet of the tunnel at the bottom of the mill to pick up and return to the Deister tables any spills escaping down the tunnel which in the past have gone to waste. The use of Oliver filters for dewatering the flotation concentrates has been discontinued owing to the expense entailed in upkeep and cost of fuel for subsequently drying the dewatered product. The concentrates are now delivered direct by means of launders into dams whence, after draining, they are spread on the ground, sun-dried, broken up, screened, and railed to the smelter. However, with this method of treating flotation products, the ratio of silver to lead production at the smelter will be lower during the rainy season, and higher during the dry season, than would be the case if flotation products were treated currently. The change in the flow-sheet in the month of December permitted the shutting down of four out of six tube-mills, which resulted in a considerable saving in power, repairs, and supplies, with a consequent reduction in the cost of milling. The coarser grinding since December has increased the capacity of the mill by reduction of lost time, due to overloading of re-grind elevators and screens.

In consequence of the decision in August, 1919, to build a new smelter on a site near the new mill, the old plant was not kept in an efficient state of repair, and at the time of Mr. Marmion's first visit, in February, 1921, was in a very poor operating condition. At this time, work on the new smelter had already been stopped pending the result of investigations on the spot, and, after consideration of all the factors, he recommended the abandonment of the idea of a new smelter and the adoption of the far cheaper and equally satisfactory scheme of remodelling and enlarging the existing plant on such lines as the lay-out would permit. A start was made with the work of remodelling and enlarging the plant in the beginning of October, 1921, and it is estimated that it will take about two years to increase its capacity to the extent necessary to enable it to handle, in an efficient manner, the products resulting from the milling of 700 tons of average grade ore per day. This work must be carried out with as little interference as possible with production, with the result that during the rainy season, when labour is scarce and inefficient and transport conditions very difficult, there must be a slowing down and at times an almost complete stoppage of all constructional work, which will make the time occupied in its completion far longer than would be the case if the work could be carried on in a straighforward manner. It is not expected that the metallurgical efficiency of the plant will show

any great improvement until the arrangements contemplated for the recovery of the metal losses from the sintering plant and blast-furnace gases are complete, but it is nevertheless expected that the production of lead and silver will show a gradual increase as each additional new unit of plant is erected and comes into operation.

The main units of plant comprising the old smelter were :—Six Godfrey roasters ; three primary Dwight-Lloyd sintering machines ; two secondary Dwight-Lloyd sintering machines ; twenty-three Huntington-Heberlein sinter pots ; four blast-furnaces and accessory blower plant ; refinery and silver room plant, having a maximum capacity of about 3,000 tons refined lead and about 300,000 oz. silver per month.

The following lead-bearing products and fluxes were elevated from the smelter receiving bins for treatment in the smelting plant during 1921 :—

	Tons.
Dry-crushed high-grade ore	13,121
Dry-crushed mixed ores	1,067
Slimes products from Mill	11,041
Concentrates from Mill	73,440
Total lead products	98,670
Return crushed sinter and sinter fines	18,275
Crushed furnace barrings	5,527
Flue dust and crushed furnace linings	462
Granulated slag	1,953
Crushed iron ore	29,463
Crushed quartz	657
Total	155,009

The following represents the tonnages of material treated and produced by the Godfrey roasters and primary Dwight-Lloyd :—

	Tons treated.	Tons produced.
Godfrey Furnaces	55,850	53,616
Dwight-Lloyd Primary Machines	99,410	94,926
Total	155,260	148,542

The following tonnages were treated and produced by the Dwight-Lloyd secondary machines and Huntington-Heberlein pots :—

	Tons treated.	Tons produced.
Dwight-Lloyd and Secondary Machine	54,371	51,086
Huntington Heberlein Pots	103,994	96,102
Total	158,365	147,188

The average sulphur content of the Dwight-Lloyd sinter was 3·6%, and of the Huntington-Heberlein pot sinter 3·2%. During the period under review, the ore-receiving bins were renovated and extended, and a system of bedding the charges for the primary Dwight-Lloyd machines was introduced. A new crushing plant of increased capacity was installed to crush the primary sinter to the desired size, as the plant hitherto in use was not capable of turning out a suitable product. The work done in the sintering plant has been more efficient as a consequence of these improvements. It is proposed to further extend the bedding bins, and a great deal of work has been put in hand to this end. Plans for storage bins to hold 500 tons of primary sinter were prepared, and it is proposed to change the pan-conveyor system of transporting this hot product to the more flexible and less expensive system of truck conveyance. The installation of this system will permit of the material being cooled down and damped before being crushed and trommelled, thus eliminating the dust nuisance which is unavoidable in crushing hot material. The primary sinter will be delivered from the storage bins by a belt-conveyor to a new crushing plant, whence after being trommelled it will pass to another belt system to be delivered into bins commanding the feed hoppers on top of the secondary sinter machines and Huntington-Heberlein pots. The ultimate rearrangement of plant provides for all the primary Dwight-Lloyd machines being in line, with adequate and efficient feeding arrangements at one end of the line and ample ground space available for future extension at the other end. At the present time this latter end of the plant is occupied by sinter-crushing plant and secondary machines all of which will be demolished stage by stage in the process of reconstruction. The secondary sintering machines are being placed in line with, and at one end of, the line of Huntington-Heberlein pots at an elevation which will enable them to be fed from the same belt-conveyor system and with space available for further extension as required, while the ground at the other end of the Huntington-Heberlein pots is being cleared to permit of an additional six pots being erected. A flue system of adequate dimensions is being constructed, into which the gases from the sintering machines and Huntington-Heberlein pots will be forced. This flue passes under the bedding bins to connect with a large settling chamber before passing into another flue which is being constructed up the side of an adjacent hill, and which will finally exhaust the sulphur fumes into the air at an elevation of about 650 ft. above the ground level of the smelting plant. The total length of flue system, inclusive of the settling chamber, will be about 2,600 ft., and it is anticipated that there will be a considerable reduction of the dust and fume losses that are known to occur in the sintering operations as a consequence of the settlement that will take place in the system. During the year a trial was made of returning a proportion of re-crushed secondary sinter to the Dwight-Lloyd bedding system in order to open up the charge and reduce its sulphur content. The results were excellent, and crushed sinter is now an essential constituent of the bedded material delivered to the primary Dwight-Lloyd machines.

The work done in the four blast-furnaces reflected the improved work in the sintering plant. With the improved quality of sinter, the furnace troubles were greatly minimized and operations were more uniform, with the result that there was an improvement in production. During the year, the furnace charge bins were covered, as a consequence of which operating conditions during the rainy season were greatly facilitated. No difficulty was experienced in maintaining a sufficient operating force of labour on the furnace charge floor during the rains under these improved conditions.

Including 11,695 tons of refinery drosses from current production and 3,040 tons of furnace barrings accumulated in previous years, the four blast-furnaces smelted a total of 158,418 tons, having an average assay value of 33·7% lead,

12·85% zinc, and 31·4 oz. silver, for the following yield of hard lead :—37,720 tons from ore ; 7,513 tons from refinery drosses ; 866 tons from furnace settlers ; total, 46,099·70 tons. The average assay value of the hard lead was 95·757% lead and 107·99 oz. silver. The 3,040 tons of accumulated furnace barrings contained 804 tons of lead. 667 tons of nickel speiss and 1,026 tons of copper matte were recovered in the course of smelting operations and were stacked for future treatment and realization. 19,849 tons of coke were used in the blast-furnaces, equal to 12·5% on the charge smelted. 72,395 tons of slag were produced, having the following approximate analysis :—Ag, 1·136 oz. ; Pb, 4·02% ; ZnO, 24·73% ; FeO, 32·45% ; SiO_2, 23·09% ; CaO, 5·658%. The above percentage of lead in the slag is equivalent to a loss of 6·388% on the total lead content of the material smelted.

Extensive alterations and additions were made to the refinery and silver room during the year. To minimize the theft of silver, a change and search room for employees engaged in the silver room was built and put into operation with good effect. While it is not thought that this innovation has entirely stopped the leakage of silver by theft, it has certainly reduced it, and it is expected that the further elaborate steps now being taken will ultimately prove absolutely effective. The work of extending and modernizing the refinery and silver room was started in October, 1921, and at the end of the year considerable progress had been made. The maximum effort was put into dismantling, extending, and remodelling the silver room section, and during the process of dismantling old furnaces and generally cleaning up the plant a large recovery of silver was made, which increased the production of that metal very materially during the last quarter of the year under review.

IMPSONITE IN NORTHERN WEST AUSTRALIA

On several occasions during the last two years reference has been made in the MAGAZINE to the discovery of an asphaltum in the Kimberley division, West Australia. Particulars of this occurrence, with speculations as to its genesis, were given in a paper read by R. A. Farquharson, Government Petrologist, before the Royal Society of West Australia, and quoted in *Chemical Engineering and Mining Review*, of Melbourne, for September.

The first samples of this material were received by the Geological Department at the end of June, 1920, from Walter Oakes, of Ningbing Station, Wyndham, who believed the material to be oil shale or coal. Later, other samples were received from near the junction of the Ord and Negri Rivers. Mr. Blatchford, who was at the time in West Kimberley, was instructed to inspect the area in which the finds were made. He not only confirmed the discovery of the material by Mr. Oakes, but found that years previously it had been found in sinking a well near Texas Homestead, on the bank of the Ord, some five miles up from the junction with the Negri, and he concluded that the material occurred at least at intervals throughout these five miles.

The samples consist of a black mineral with a brilliant lustre, which is very brittle, combustible, and mostly seamed with cracks. At first sight it closely resembles anthracite coal, but investigation of its physical and chemical characters proved that it is not a coal, but an asphaltum. It ignites and burns freely and does not melt on heating even above 300° C. Its density is about 1·145 and its calorific value is 16,573 B.th.u. Proximate analysis of it gave 0·37% of moisture, 41·54% of volatile constituents, 56·27% of fixed carbon, and 1·82% of ash. The volatile matter consisted of 1·74% of water, 19·89% of oil, and 19·91% of gas. Comparison of its characters with those of similar minerals from America shows beyond doubt that the mineral is a solid asphaltite that can be included under glance pitch or manjak used as a group name. According to Dr. Simpson it most closely agrees with the variety impsonite first described more than twenty years ago from Indian Territory, U.S.A.

The importance of the asphaltites and closely related substances lies in the fact that they are indications of the past or present existence of petroleum in the neighbourhood in which they are found. They are produced by the drying of petroleum, that is, as the residual products of natural distillation, and between oil and asphalt there are all stages ranging from the liquid to the solid state, the differences between the stages being largely due to differences in the composition of the original oil and in the degree of drying.

The rock in which the impsonite occurs is a fine-textured dark-green basalt, in part massive or only slightly fractured, in part so fractured as to be almost a breccia. The appearance of the surfaces of the rock, the shear planes and the cracks, as well as the occurrence of the mineral along the cracks, show clearly that the fracturing is not due to the amount of blasting that was necessary to get the specimens. The outstanding features of the rock are its extremely vesicular character and the fact that quite a number of vesicles are filled with impsonite. The vesicles range in size from a pin-head to a walnut. Some are spherical, others elliptical, and others again almost disc-shaped. The material filling them is different in different vesicles and consists variously of calcite, greenish chlorite, quartz, impsonite, and impsonite and calcite.

The impsonite occurs in the rock in a variety of ways :—(*a*) in vesicles, filling the whole of the cavity ; (*b*) in vesicles with calcite ; (*c*) in very thin strings along cracks in the rock ; (*d*) in large strings and patches in the sheared rock. Sections of the black filling of the vesicles show it to be quite homogeneous, and to contain no remains of any other mineral.

The general geology of the locality of the find and of the surrounding district was first mapped by Hardman in 1885, and later in 1906 by Dr. Logan Jack, whose map was naturally to a large extent based on that of Hardman. The work of these two geologists has up till quite recently been accepted as a correct exposition of the structure and stratigraphy of the district. According to Hardman, along the western side of the Ord River and extending eastward on the south side of the Negri, are two belts of sandstones and grits that have been placed as Upper Carboniferous. Immediately underlying these are thick limestone beds which are of Lower Carboniferous age. Under

the limestone is a very extensive basalt sheet. There is no evidence of contact metamorphism in the limestone, a fact which, together with the vesicular nature of the basalt, renders it improbable that the basalt is intrusive. Underlying the basalt are older sandstones, grits, shales, etc., probably of Devonian age, which rest on slates, schists, gneisses, etc., possibly Lower Silurian or Upper Cambrian in age. It is clear, therefore, that according to Hardman, the limestone is Lower Carboniferous in age. The basalt, in which the impsonite is found, occurs as a sheet under this limestone, and therefore under the basalt are rocks probably of Devonian age. It follows, then, that the basalt is either Upper Devonian or Lower Carboniferous in age.

Hardman in 1883-1884 collected a series of fossils from the bed of the Elvire River, in rocks which he subsequently mapped as Lower Carboniferous and which Dr. Jack also assigned to this age. These fossils were examined by Etheridge, Woodward, and Foord, and determined as fossils of undoubted Cambrian age. Further, Hardman also collected fossils from the Ord River, five miles below its junction with the Elvire, and at Mount Panton, just east of the West Australian border, and these also were subsequently determined as of Cambrian age. Moreover, in 1909, H. W. B. Talbot had occasion to visit the Ord River, and from a cliff near Ord River Station he collected a fossil, subsequently assigned to the Cambrian age. According to Maitland, strata similar to those near Ord River Station extend from the Hardman Range to the Osmond Range, and both Hardman and Jack have this area mapped as Lower Carboniferous or Devonian.

It is evident, therefore, that the limestones extending from Mount Panton to the Hardman Range cannot all be of Lower Carboniferous age. In at least three localities the limestones are, from the fossil contents, beyond question of Cambrian age. As, according to Hardman, undoubted Lower Carboniferous limestones do occur at Mount Panton, it follows that they are of two ages, Lower Carboniferous and Cambrian. The maps, therefore, of both Hardman and Jack should be amended to show the occurrence of Cambrian limestones at Mount Panton and in the valley of the Ord River. In particular, Hardman's section across the valley of the Ord should be altered to show the presence of Cambrian limestone under the Devonian and outcropping in the valley of the river.

The important feature of the presence of limestones of both ages in the Ord valley is the extent to which it affects the age of the impsonite-bearing basalt. Up to the present it has been accepted that Hardman's section is correct and that the basalt is of Lower Carboniferous or Upper Devonian age. There is, however, now introduced the possibility of the limestone being of Cambrian age. If this should be the case, then the basalt which occurs under the limestone, and which can scarcely be a dyke or a sill, would be of Lower Cambrian age. Basalts apparently similar to those at Oakes' Find occur in the Northern Territory, and, according to Woolnough, they are probably of Lower Cambrian age.

On the other hand, as Hardman had some grounds for mapping the limestones as Lower Carboniferous, it is most probable that the limestone overlying the basalt is of this age, that the Cambrian limestone outcrops only in isolated places, and that Devonian, and perhaps Ordovician fossiliferous rocks may subsequently be found between the Carboniferous and Cambrian in the district. It will be realized, therefore, that the importance of an accurate determination of the stratigraphy of the district cannot be exaggerated.

The original impsonite mineral found in Indian Territory, U.S.A., though similar to that at Oakes' Find, occurs as a vein in greenish shales that are included between sandstones 100 to 150 ft. apart, which are of Ordovician age. It occurs, therefore, in a manner quite different from the impsonite at Oakes' Find. In a report, entitled "The Prospect of Finding Oil in South Karroo, South Africa," Rogers mentions the occurrence of a bright black substance filling fissures, but no detailed account of the material has yet appeared, though there is little doubt that it closely resembles the material from Oakes' Find. Just recently an article by A. L. Hall, published in the transactions of the Geological Society of South Africa, describes an occurrence of oil and oil residuum near the Orange Free State border that bears a remarkable resemblance to the one in East Kimberley. In a dark volcanic basalt are seams of tarry matter and small pockets of dark-brown liquid bitumen. The basalt is vesicular, and the vesicles are filled with a black material or with a light-coloured mineral surrounded by a shell of the black substance. Not only the solid black material was found in the rock, but actual pockets of liquid oil, and from one of the largest of these one gallon of oil could be siphoned off. The basalt is 42 ft. thick, and it is impregnated for a horizontal distance of 4,500 feet and for the whole of its thickness. Hall regards the black material now filling the vesicles as an alteration product of the mineral which filled the vesicles prior to the impregnation of the rock by volatile hydrocarbons, and he regards the oil indications as most likely due to natural distillation from oil shales by vertical basic dykes under the basalt. The remarkable similarity between the South African and the West Australian occurrences will be at once realized. The important differences are :—(*a*) the basalt at Oakes' Find is sheared or shattered ; (*b*) both the age and the succession of the rocks are different ; (*c*) no basaltic dykes have been found in the East Kimberley district ; (*d*) the vesicles in the basalt at Oakes' Find are, when black, completely filled by impsonite and are not an impregnation of another mineral by volatile hydrocarbons ; (*e*) no liquid oil has been found in any of the vesicles from East Kimberley.

The mode of occurrence of the mineral in the basalt, the composition, structure, and conditions of formation of the rock indicate that the original oil was not formed in the basalt, but has entered it from some other source. Further, the fact that the mineral is most common along zones of shearing or cracking in the rock, and that there is apparently some degree of impregnation of the rock substance in the vicinity of the shear zone, strongly suggest that the shearing has allowed of the penetration of the rock by the original hydrocarbons in fluid form. It is possible, of course, that these hydrocarbons existed in cavities in the basalt before the shearing, and that the latter allowed of a movement of the fluid in the rock mass itself. Moreover, if, following the example of most authorities, we put aside the inorganic origin of oil, then the

original material which by inspissation formed impsonite must have been derived from limestones, sandstones, carbonaceous or oil shales, whether fossiliferous or not. As only limestones that have been dolomitized, fissured, or jointed are known to contain petroleum in any quantity, only those affected in these ways need be considered. In addition, it has been pointed out by Cunningham Craig and others that the absence of phosphates in the composition of petroleum, as well as their absence in the vicinity of any large deposit of oil, is evidence against the derivation of any considerable quantities of oil from a limestone source. The limestones in the district, so far as investigations have shown, are not dolomitized, channelled, or fissured, and contain only doubtful traces of impsonite in proximity to the basalt. Sandstones are reservoirs for oil produced from other formations, rather than deposits from which hydrocarbons may be derived by distillation.

In view of these considerations, several hypotheses or explanations of the origin of the mineral in East Kimberley present themselves for discussion, of which the two following appear the most probable :—

(1) That between the basalt and the overlying limestone, carbonaceous or oil shales are present in certain places, though, owing to overlapping or faulting, they do not appear in others; that by distillation of these shales, volatile hydrocarbons have been produced, and these, under pressure, have followed along the plane of separation of the basalt or the shales and the overlying limestone, and on emerging at the surface have impregnated the basalt to some extent at its junction with the limestone; that, in other words, the fluid oil has really migrated from places where the shales existed to others where escape at the surface was possible. The distillation of the hydrocarbons may have been brought about by heat and compression due to deep burial and folding of the strata. Though this hypothesis is somewhat attractive it is still difficult to understand why, although the effective porosity of the overlying limestone is at least as great as that of the basalt, only the basalt should contain the impsonite in considerable quantity. One would expect at least an equal amount of the original oil or oil residuum in the limestone in proximity to the basalt. Yet, up to the present, only doubtful traces have been discovered, though this may be due to insufficient observation.

(2) That the basalt is really composed of successive flows; that after one period of volcanic activity there was such a long interval of quiescence that carbonaceous shales were formed on the surface of the basalt; that another extrusion of basalt then took place, and the molten lava flowing over the shales distilled the hydrocarbons from them. These hydrocarbons in part escaped into the atmosphere, in part became imprisoned in the vesicles or holes in the basalt. Subsequent local shearing or faulting (when the surface of the basalt had become weathered) caused cracks in the rock and the fluid hydrocarbons from the holes penetrated the cracks, and later both in the vesicles and the cracks formed impsonite. This explanation is feasible, provided molten basalt is capable of occluding hydrocarbons without causing their disintegration or combustion, and, as the distillation of the shales would have been completed long before the deposition of the limestone, no appreciable amount of oil or oil residuum would be expected in the limestone.

AN OCCURRENCE OF BITUMEN AT BOMBAY

In the *Records* of the Geological Survey of India, Vol. LIV, part 1, 1922, Cyril S. Fox gives an account of an occurrence of bitumen recently discovered in the vicinity of Bombay, and examined by him. The term " bitumen " is used by the author in its comprehensive sense as including mineral pitch, ozokerite, and petroleum. The amount discovered is quite small and it has no commercial value, but its presence provokes an interesting geological discussion, and contributes some evidence as to the origin of petroleum and allied organic substances.

Bombay Island consists of a low-lying plain about 11 miles long by 3 to 4 miles broad, flanked by two parallel ridges of low hills. Geologically the island appears to consist of a conformable series of basaltic lava flows and interbedded sedimentary beds which dip gently 10° to 15° to the west and have a general strike of N. 10° E. to S. 10° W. These rocks are well seen in the hills on each side of the island, whereas the central plain is covered with recent alluvial deposits. An announcement was made in the local press for July 29, 1921, to the effect that petroleum, mineral wax, and bitumen had then quite recently been discovered within the municipal limits of the city, at a road-metal quarry at Sewri. Asphalt had, however, been recorded from the same place three years before, when Sir Henry Hayden, then Director of the Geological Survey of India, had visited the locality and collected specimens from the quarry. He found that the asphalt occurred as a layer on the floor of a large, low-roofed cavity in a peculiar greenish dolerite. The sides and particularly the roof of the cavity were lined with crystals of various minerals, chiefly calcite, quartz, and zeolites, all of common occurrence in the geodes of the Deccan Trap of India. In addition, the whole inner surface of the cavity—floor, sides, roof, and the faces of the encrusting crystals—was lightly coated with specks and chip-like fragments of hard, black, bituminous matter.

The existence of this material gave rise to many speculations. Where did the bitumen come from ? Was it carried up with the basaltic lava as an essential constituent from the plutonic magma ? Or did the dykes of dolerite break through coal-bearing beds, or through strata containing an abundance of animal remains, as they forced their way to the earth's surface ?

The probability of oil-bearing beds beneath the traps of Bombay had never been seriously entertained, for the simple reason that the basalts of the island, probably of Upper Cretaceous age, are much older than the Nummulitic (Eocene) beds of Surat and Kathiawar, whereas the petroleum horizons in India and Burma occur in Miocene strata of the Tertiary period. The possible existence of a hidden coalfield, buried under the traps of Western India, had long been recognized. But, as this question was already receiving attention from the Great Indian Penin-

sular Railway, there seemed to be nothing to do but wait until the results of the proposed boring at Bhusawal were available. The possibility that the presence of lenticular patches of clay matter and of an abundance of frog remains, which were known to occur in the interbedded sedimentary beds of Warli and elsewhere, might offer an explanation was not examined owing to the assumption, based on previous careful mapping, that the traps were simple lava flows.

When the fresh discoveries of bitumen—asphalt, mineral-wax, and petroleum—in the Sewri quarry were made in 1921, Mr. Fox was deputed to make an examination. We take the following from his report :

The Sewri quarry is being worked in a single rock-mass of a peculiar, greenish dolerite. This material has been found sufficiently hard and tough to make an excellent road-metal. The rock is jointed and has a rough-bedded appearance owing to the preponderant development of discontinuous horizontal joints. The irregular joint-planes have a distinct slope or dip to the west at low angles. All the cavities are found in a small area of the quarry, along a north and south strip 150 ft. long by 30 ft. wide. The largest cavity, that of 1918, was uppermost and the new ones occur at various levels below it. The vertical height from the roof of the big (1918) cavity to the floor of the lowest at present seen would not exceed 15 to 20 ft. The big cavity has unfortunately been destroyed, but its size is stated to have been 20 ft. wide, 30 ft. long, and 8 ft. high under the crown of the dome. The recently exposed cavities are much smaller, and are said to have been full of water. In one instance this water is known to have been saline ; but little importance can be attached to this point, as the sea is barely half a mile away and not at a very much lower level. The cavities have a certain feature in common—their floors are generally plane surfaces which dip gently to the west—so that the solid, black bitumen is found accumulated as a layer on the dip side. The internal structure is similar to the large one described by Sir H. Hayden. The sides and roof, and also the surface of the bitumen on the floor are encrusted with crystals of calcite, quartz, and various zeolites. Occasionally, beautiful, little, doubly-terminated, quartz crystals are found on the surface of the bitumen on the floor. Sprinkled over the whole encrusted surface there are specks and tiny fragments of solid black bitumen. On the surface of the asphalt from a cavity immediately below the site of the large one there were a few clotted patches of mineral-wax, while from the lowest cavity both mineral-wax (ozokerite) and thick liquid petroleum were found on the surface of the asphalt. The liquid petroleum had become quite viscous when Mr. Fox saw the specimens. These samples were unfortunately collected without due regard to their mode of occurrence in the cavity and the accounts received on the ground tended to confuse the problem at issue. It was difficult to make certain if the ozokerite and petroleum were floating on the water when the cavity was first opened. It is certain that these substances were collected from the floor when the water drained away.

According to an examination of specimens from the top cavity the pitch is amorphous, and in thin section quite structureless ; its fracture is usually conchoidal but sometimes remarkably plane. The lustre is vitreous to dull. The colour is black, but delicate surface films of limonitic material impart various colours to it, mostly pale yellow to brown, but occasionally green or whitish, and sometimes beautifully iridescent embracing all the colours of the spectrum. The streak is also black. It is not a homogeneous substance, part of it being soluble in carbon disulphide and part not. It burns easily in air with a smoky flame and the resulting ash consists largely of ferric oxides. Heated in a neutral atmosphere the pitch gives a slight brownish distillate ; otherwise it is non-volatile.

The most acceptable view regarding the formation of petroleum is that certain forms, chiefly aquatic types, of vegetable and animal matter, when decaying by putrifaction or fermentation, become subject to bacterial action whereby the cellulose in the plants and the albumen (nitrogenous tissues) of the animals are attacked and eliminated, while the fatty matters at first remain ; that subsequently, by saponification of these glycerides, free fatty acids are produced and the waxy esters are more or less hydrolysed ; and that at a later stage carbon dioxide is given off from the fatty acids and esters and finally the petroleum is formed. Although the processes involved in the various stages of petroleum formation appear to take place exceedingly slowly in nature they do not require great pressures or high temperatures to promote their reactions. The essential product is petroleum and it is from this liquid that natural gases are given off and, if it is exposed to slow evaporation and atmospheric oxidation, mineral-wax (ozokerite, etc.) and asphalt may be left as residual products of the petroleum. This view obviously implies that the formation of petroleum takes place in the rocks in which the organic remains were originally entombed. The evidence in the quarry pointed to the hydrocarbon having been included in the dolerite while the latter was in a plastic hot condition, and suggested that the original, organic, bituminous matter had evidently suffered some degree of distillation, the various cavities representing bubbles or pockets in which the evolved gases had accumulated. The presence of unescaped gas bubbles as large as that of the big cavity, a volume of roughly 1,000 cu. ft., appeared difficult of explanation in a supposed lava flow. It would have seemed more natural for the gas bubbles to rise to the surface of the molten lava and eventually to escape, either into the air or into the sea, according to whether the flow was of subaerial or submarine type. The question is whether the lava became so viscous as it spread over the surface of the ground, or sea bottom, that even large bubbles of gas could not escape, or whether the dolerite of Sewri is part of a sill.

The evidence is very strongly in favour of the structure of Bombay Island being due to the faulting of a single group of bedded rocks which consist of an intrusive sill of dolerite, a series of fresh-water sedimentary beds with abundant plant and animal remains, and an overlying mass of trachytic trap. Once this structure is admitted there is no need to speculate on the possibility of coal or oil bearing strata beneath the traps of Bombay. All the facts can be accounted for from the evidence available in

the fossiliferous, fresh-water, sedimentary beds. These beds are known to be missing from the section seen in the Golangi hill quarry and it is considered that their absence is not due to lack of deposition, but to their subsequent local removal by the intrusion of the lower trap, as this mass of molten rock forced its way along the horizon of the sedimentary beds. The best exposed section, a thickness of over 30 ft., of these fresh-water strata is seen at the south-west end of the Warli ridge just north of the Love Grove pumping station. Several observers have noted the lenticular patches of bright coaly matter in the upper part of the beds, and the frog beds of the lowest part of the section are well known. Carter actually marked the word "coal" on his map in this vicinity, and subsequent writers have spoken of the abundance of carbonaceous matter in the upper part of the sedimentary beds. This "coal" although bright and hard and of the appearance of anthracite burns easily in air with a smoky flame and great intumescence.

J. Ribeiro, before the Bombay Natural History Society in 1921, describes the lower part, the frog-beds, of the Warli section as follows: Immediately resting on the lower trap there is a layer about 3 or 4 in. thick of a very dark coloured shale in a good state of preservation which splits into very thin laminæ. It consists of an extremely fine sediment, so fine that when held against the sunlight it gives out iridescent colours. When wetted and exposed to the sun it emits a strong smell of naphtha. This is more pronounced in a newly broken rock and the quarrymen are quite aware of it. This napthous smell is probably the result of the large amount of organic matter incorporated in the shale.

These and many other similar observations are significant when it is known that the total quantity of asphalt and other bituminous matter taken from the several cavities so far exposed is trifling, an amount not exceeding 5 cwt. This quantity could be easily accounted for as having come from the mass of the sedimentary beds which are missing from the Golangi hill section, assuming that these beds had as much organic matter present in them as is known to occur in the Warli section. With these points in view it is unnecessary to speculate on vague sources for the origin of the bitumen. The occurrence is of great scientific interest, but unfortunately it holds no potentialities of an important commercial nature.

Suction Cutter Dredges.—After having been out of fashion for a dozen or more years, the suction cutter dredge is once more being strongly advocated for alluvial mining. Thompson & Co., of Castlemaine, Victoria, have always been advocates of this type. They give details of one recently supplied to a tin property in Malaya in the *Industrial Australian and Mining Standard* for September 28. This article gives information relating to this type of dredge, as recommended by this firm particularly in connexion with its application to clayey ground. As dredges of this type are little known nowadays, it may not be out of place to quote from this article.

The dredge consists of a floating hull or pontoon, either of steel or timber construction, on which is erected the necessary power plant, either steam, gas, or electrical. A well or opening is formed in the pontoon, in a way similar to that employed with bucket dredges, into which a rising and falling ladder is fitted. This ladder is pivoted near the deck level, the pivots being arranged co-axial with a centrifugal gravel pump of suitable capacity to handle the specified yardage. The ladder is suspended in a way similar to that employed for a bucket dredge, and is raised or lowered by means of a special winch operated independently of the usual multi-barrel winch which is employed for manœuvring the dredge pontoon. On the lower side of this ladder the suction pipe-line is rigidly fixed, and on the lower or extreme end of the suction pipe there is provided a suitable revolving cutter. The cutter is formed of a specially designed steel frame provided with renewable cutting blades of high-carbon steel, so as to reduce wear to a minimum. These cutters can be supplied of various designs to suit the material to be handled, and can be changed, when desired to deal with the roots of jungle or with bands of conglomerate. On the upper side of the ladder, and running in bearings parallel with the suction pipe, is the cutter shaft, on the lower end of which is fitted the cutter in such a position that it revolves in close proximity to the inlet end of the suction pipe. The cutter is arranged to partly envelop the end of the suction pipe, so that the material excavated is swept in close to the mouth of the pipe, and is thereby induced to enter the pipe with the inflowing water. A separate engine is employed for operating the cutter, so that its speed may be varied as required to meet altered conditions, without interfering with the speed of the main gravel pump which normally operates under a constant head. The discharge pipe from the gravel pump can be directed to any convenient point on the pontoon, so as to discharge the material over plain grizzly bars; it is not necessary to pass all the material through a revolving screen as is customary with bucket dredges. Complete separation of earthly matter from the stones, and the disintegration of clay lumps, is effected by the whirl of the pump impeller, so that the grizzly bars are simply used for separating the larger stones and tenacious hard clay lumps from those particles which are suitable for passing into the sluice-boxes.

With this system of dredging it has been found that fully 90% of the material pumped will pass through the grizzly bars into the sluice-boxes, and unless there is a fair proportion of lumpy clay associated with the discarded stones, the latter can be directed over the stern of the pontoon after leaving the grizzly; but if it is desired to further rumble and separate the stones from other matter associated with them, this can be done by employing a comparatively small trommel or revolving screen, seeing that but 10 to 15% of the material pumped has to pass through it. As the ratio of solids pumped to that of water handled by the gravel pump is high with this method of operation, it is found necessary to supplement the supply of water by means of an independent centrifugal water pump. This latter pump should also be driven by an independent engine, so that the quality of water may be adjusted as required.

The arrangement of the sluice-boxes is very much simplified with this type of dredge compared with that adopted for bucket dredges. In the case

of the latter, the tumbler framing prevents the boxes being carried forward so as to utilize the area of the pontoon, with the result that two planes or tiers of boxes are necessary to obtain the required area; whereas with the suction cutter dredge the boxes may be arranged to cover the whole area of the pontoon, and thus obtain the necessary area with one plane, which leaves plenty of room on the deck, and incidentally the boxes form the roof of the housing.

Before starting operations, the dredge recently sent to Malaya was subjected to the usual criticism. Some said it would be incapable of dealing with an irregular bottom; others foresaw trouble with sunken logs; and still others were sure it would not raise the tin-bearing dirt from between boulders so well as could be done with a bucket-dredge. The suction dredge has proved capable of meeting at least two of these conditions much more effectively than any bucket dredge can hope to do; and in the other case, that of dealing with sunken logs, the only difference is that it will not raise these to the surface as is often done with a bucket dredge, but they can be conveniently removed by means of a swinging crane and grab.

As regards cleaning up an irregular bottom, the suction dredge can fossick in depressions that a belt of buckets could not be operated in; and, unlike the buckets, which can only raise that which they actually remove by slowly scooping up, the suction effect which creates a high velocity of flow into the end of the suction pipe will induce material to enter the pipe that may not have been disturbed by the cutter, so that secluded harbours, or crevices, may be cleaned out by the rapid flowing action of the water towards the end of the suction pipe.

Again the flow through the pump and pipes is continuous, ensuring a continuous discharge on to the sluice-boxes; this will be recognized as an important feature in permitting the tin to settle uniformly in the boxes.

It will be recognized that, with a constant uniform turning effort applied to the cutter having a spinning or rotary motion, the vibration, or shock due to impulse, is obviated; and, as the motion of the main centrifugal pump is of a similar nature, the pontoon construction need not be of such substantial construction as that demanded by a bucket dredge of equal capacity. The pontoon construction is thereby much simplified, and it is a less costly nature. Independently of these considerations the simpler pontoon has the further advantage of shortening the time for erection which, as applied to bucket dredges, is often the cause of much unforeseen cost and irritation, not to say anything of the additional cost of transport.

As regards the distribution of the plant on the pontoon, the plant is uniformly spread over the whole area. This is of advantage in maintaining a uniform trim when the sluice-boxes also cover the full area of the pontoon.

The following is a summarized comparison betwen a bucket dredge and a suction cutter dredge of equal capacity:—(1) For equal output the first cost of a suction cutter dredge is certainly not more than half that of a bucket dredge, which means that considerably less capital is called for. (2) Owing to the disintegrating effect of the revolving cutter, which sluices and breaks up large pieces of either clay or friable material, coupled with the puddling action of the pump impeller, complete separation of the tin-bearing earth from the stones is assured. This not only ensures a continuous supply of material to the boxes, but it obviates the necessity of using a large revolving screen, with the wear and tear and continuous demand for power associated with its use. (3) With the sluice-boxes carried on the main pontoon, the head to be pumped against is a minimum, so that the total power required for a suction cutter dredge is about the same as that necessary for a bucket dredge when handling the same amount of material. (4) As regards maintenance, the cutter machine has considerable advantage. With a continuous chain of buckets, links, and pins associated with bucket dredges, always imperfectly lubricated, and the whole chain being continuously in motion, wear of an excessive nature is taking place the whole time, with the result that a formidable pile of discarded scrap is soon collected round the site of a bucket-dredged area. Besides this, it is no mean undertaking to replace these buckets, pins, bushes, and other parts. In the case of the cutter machine, the only two parts subject to erosive wear are the revolving cutter blades, which are conveniently and cheaply renewed, and the renewable liner of the main gravel pump. Not more than half a dozen working parts are submerged when the plant is in operation, so that all other parts can be inspected, and properly lubricated without stopping.

Close Mining on the Rand.—The October *Journal* of the South African Institution of Engineers contains a paper by W. A. Quince on the elimination of waste rock in its relation to the decrease of mining costs per ounce of gold won, which is regarded by the author as a better criterion of profitable mining than the cost per ton of ore milled.

The elimination of waste rock is divided into three distinct methods: (1) Resuing; that is, mining out the waste first; (2) lower stoping widths, mining less waste; (3) sorting waste, removing mined waste before treatment, underground and on surface.

(1) Where the leader is narrow, it may be more profitable to mine out the waste above or below the leader, and then reclaim the leader with as little waste as possible, than to mine the leader together with sufficient waste to make up the necessary stoping width.

The author takes the following specific example: 4 in. reef at 40 dwt. per ton; 32 in. stoping width; 4s. per ton mining costs; 1s. per ton shovelling and packing waste; 2s. per ton reclamation of reef; 16s. per ton costs after mining; 20s. per ton total costs per ton milled for stoping; 8 in. hanging waste and 8 in. foot-wall waste with resuing.

Results based on (*a*) stoping one fathom: 32 in. gives 8 tons per fathom at 20s. per ton; 4 in. reef at 40 dwt. gives 2 oz. gold per fatham. Thus 2 oz. gold cost 160s. to produce, or £4 per oz. (*b*) Resuing one fathom: stoping 32 in. of waste at 4s. per ton gives 8 tons at 4s. or 32s.; shovelling and packing 8 tons waste at 1s. per ton equals 8s.; reclaiming 20 in. of reef and waste equal to 5 tons at 2s., 10s.; further treatment of 5 tons of ore at 16s. equals 80s.; total cost per fathom, 130s. Thus the cost per fine ounce is £3 5s.

The cost of resuing 5 tons of ore is 130s., therefore the cost per ton milled by resuing is 26s. per ton, and the cost per ton milled by stoping 20s. per ton, giving the cost per ton milled by stoping 6s. less than by resuing; but an extra profit of 15s. per fine ounce of gold produced is obtained by resuing as against stoping.

It is obvious that with resuing, the less waste that

has to be reclaimed with the reef and subsequently treated the lower the cost per fine ounce of gold produced, and therefore the greater the profit; also the higher will be the cost per ton milled.

The factors governing profitable resuing are: (*a*) parting planes, which decide the thickness of the waste reclaimed with the reef; (*b*) thickness of reef (the narrower the reef the more waste there is for elimination); (*c*) the cost per ton after mining (should the cost per ton after mining be very low, treatment might prove cheaper than elimination of waste); (*d*) cost of disposal of waste; (*e*) cost of reclamation.

(2) The effect of the stoping width on the cost per fine ounce of gold produced is not properly appreciated. Using the same figures: 4 in. reet at 40 dwt., 32 in. stoping width, 20s. per ton milled costs; these give a cost of 32s. per fathom for mining. Increasing the stoping width will usually not increase this charge.

Assume that the stoping width is increased by 8 in. to 40 in. Results based on cost per ton milled: mining 10 tons equals 32s.; further costs, 10 tons at 16s. per ton equals 160s.; total cost of 10 tons milled, 192s. Therefore cost per ton milled is 19s. 2·4d., a substantial reduction in the cost per ton milled and an apparent improvement in efficiency and prosperity. Results based on cost per fine ounce of gold produced: with 32 in. stoping width, 2 oz. gold cost 160s.; with 40 in. stoping width, 2 oz. gold cost 192s. This clearly shows the increased cost of 16s. per fine ounce of gold produced, and also the reduced efficiency and prosperity of the operations when the stoping width is increased.

Assuming that the stoping width is decreased by 8 in. to 24 in. the results based on cost per ton milled would be: mining 6 tons equals 32s.; further cost, 6 tons at 16s. per ton, 96s.; total cost of 6 tons milled, 128s. Thus cost per ton milled is 21s. 4d., a substantial increase in the cost per ton milled, and an apparent drop in efficiency and prosperity. The results based on cost per fine ounce of gold produced would be: with 32 in. stoping width, 2 oz. gold cost 160s.; with 24 in. stoping width, 2 oz. gold cost 128s. This clearly shows a reduction in the cost per fine ounce of gold produced of 16s., and the real increased prosperity and efficiency of the operations.

The following are the factors governing the profitable reduction of the stoping width: (*a*) Dip of reef; the steeper the dip the narrower the workable stoping width. (*b*) Width of reef; the narrower the reef the more waste there is for elimination. (*c*) Method of working; a hammer-drill will work where it is impossible for a hammer boy to swing his hammer. (*d*) Smoothness of foot-wall; facilitates shovelling. (*e*) Parting planes; difficulty of breaking other than to parting planes, when present.

(3) Sorting of waste is generally done at two periods: (*a*) before shovelling (sorting underground); (*b*) before crushing (sorting on surface).

(3) (*a*) Using the same figures: 4 in. reef at 40 dwt.; 32 in. stoping width; 20s. cost per ton milled. These figures give 28 in. of waste, stoped with a reef, which gives 7 tons of waste broken per fathom. Assuming 1 ton of waste sorted out and packed at a cost of 1s. per ton, the results based on cost per ton milled would be: mining 8 tons cost 32s. per fathom, 32s.; sorting 1 ton 1s.; further cost of 7 tons at 16s. per ton, 112s.; total cost of 7 tons milled, 145s. Thus the cost per ton milled equals 20s. 8·6d., an increase of 8·6d. per ton milled, which suggests a decrease in efficiency and prosperity. The results based on cost per fine ounce of gold produced would be: without sorting 8 tons cost 160s.; with sorting 7 tons cost 145s.; which shows a decrease in the cost per fine ounce of gold produced of 7s. 6d., and a real improvement in the efficiency and prosperity, in spite of the increased cost per ton milled.

(3) (*b*) Assuming costs before crushing at 15s. per ton and the same amount sorted as before shovelling, the results based on cost per ton milled would be: 8 tons at 15s. per ton, 120s.; 7 tons at 5s. per ton 35s.; 1 ton at 1s. per ton, 1s.; total cost of milling 7 tons, 156s. Therefore, the cost per ton milled is 22s. 3·4d., giving the huge increase of 2s. 3·4d. per ton in the cost per ton milled, and indicating a decrease in efficiency and prosperity. The results based on cost per ounce of gold produced would be: without sorting 8 tons cost 160s.; with sorting 7 tons cost 156s., showing a decrease in the cost per fine ounce of 2s., a real improvement in the efficiency and prosperity.

The factors governing the profitable sorting of waste rock are: (*a*) Thorough washing of broken ground, so that the waste may be seen and sorted. (*b*) Holes drilled in reef where possible, so that the most shattered portion is the reef. (*c*) Low strength explosives, so that the ground is broken into as large lumps as possible. With the profitable elimination of waste rock by any method the cost per fine ounce decreases, and therefore the profit increases; but the cost per ton milled must increase, so the much-sought-after figures of low costs per ton milled are lost. Roughly speaking, about 50% of waste rock broken in reclamation should be sortable, and about 20% in stoping.

The principle underlying the elimination of waste rock is obviously the production of as high a concentrate as possible, and the question is what steps to take to ensure the maximum profitable elimination of waste rock. The following list are some systems which have been in use: (1) Bonus for narrow stoping widths; (2) bonus for waste sorted underground; (3) bonus for grade of ore sent to mill; (4) bonus for profit; (5) severe penalties for breaking waste; (6) severe penalties for shovelling waste. Of the above, No. 4 is theoretically the best, but as there are so many other factors governing the profit, other systems have to be used. A bonus based on the following factors has proved very satisfactory: Bonus for tons per white shift; bonus for tons per native shift; bonus for cost per ton; bonus for grade; bonus for accident rate. All rock breakers (excluding developers) receive the same bonus, and other underground workers receive quarter of the amount. The penalties for (5) and (6) are loss of bonus, loss of rock-breaking job, and, lastly, dismissal.

In the early days of the Rand, sorting out of waste was only possible on the surface, and even then under disadvantages, for the following reasons: (1) Large machines were used, requiring wide stoping widths to operate in; (2) blasting gelatine of high strength was used, causing excessive shattering of the ore; (3) no water underground for washing of ore broken; (4) practically no timbering by cribs or pigstyes, requiring waste for packing, and hence no demand for waste. Compare this with the present position of to-day: (1) Abundance of water for thoroughly washing all broken rock; (2) low-strength explosives; (3) small machines that would have been regarded as toys in the old days, that will work anywhere a man can crawl into; (4) tremendous demand for waste for packing the timber pigstyes.

Red Lake, Patricia.—In the MAGAZINE for October our Toronto correspondent reported a rush

to a new silver district at Red Lake, Patricia, near the Manitoba boundary. Dr. E. L. Bruce, of the Ontario Geological Survey, has visited the district and has written a brief report which we quote herewith.

The rocks in the vicinity of the new silver field along the shores of East Bay are lava flows largely altered to greenstones or to chlorite schists. Interlayered with the lavas are light-coloured quartz-porphyries, which are also probably volcanic rocks. Along the east shore of the bay the rocks are purple and green schists of somewhat doubtful origin, with many rusty zones in which there is considerable carbonate. Calcite also occurs as blebs in the greenstones and as small stringers. These rocks are intruded south-east of Red Lake by granite. Several miles west of East Bay similar volcanic rocks are associated with slate, iron formation, and some bands of conglomerate. All the rocks are much disturbed. The original discovery, which was the only one made at the time of examination, is a vein 4 to 6 in. in width, with some parallel stringers, consisting of about equal quantities of quartz and galena. The galena is said to carry high values in silver. No native silver was seen by the writer. It is possible that silver sulphide or other silver minerals may be found on further examination, but they were not recognized in the field examination of the specimens. The original vein had been traced only a short distance. The heavy forest cover and the high water level of the lake combine to make prospecting rather difficult. It is possible that important developments may follow this find. The original discovery vein is small even though it should prove to be high grade, but further prospecting may uncover larger deposits. It should be clearly understood, however, that both the mineral association in the vein and the rocks in which the veins occur are quite different from the native silver occurrences of Cobalt and Gowganda. It will require a considerable amount of thorough prospecting and development before the value of the new discovery can be properly determined, and reports of the size of the new field and the values found in the veins should be accepted with much reserve.

SHORT NOTICES

Cementation.—The *Colliery Guardian* for November 10 publishes a translation of an article by L. Sauvestre appearing in *Annales des Mines* describing, with full illustrations, the shutting off of water by the cementation process in a new shaft at the Beeringen colliery.

Wave-Transmission of Power.—The *Engineer* for October 27 and November 4 publishes an article on the Constantinesco system of wave-transmission of power. This system was described in the MAGAZINE for February and March, 1921, together with its application to the rock-drill made by W. H. Dorman & Co.

Drill Sharpener.—The *Colliery Guardian* for November 10 describes and illustrates the "Bizzibob" drill sharpener, put on the market by the Hardy Patent Pick Co., of Sheffield.

Tacheometric Survey.—The *Colliery Guardian* for November 3 prints a paper by James Cooper on tacheometry as applied to underground surveying, read before the Institute of Mine Surveyors of Great Britain.

Magnetic Variation.—Dr. Charles Chree, superintendent of Kew Observatory, contributes to the *Colliery Guardian* for November 3 some notes on the magnetic declination data supplied by the observatory for the use of mining engineers.

Liquid Air Explosives.—The *Iron and Coal Trades Review* for November 24 gives an account of a demonstration of liquid air as an explosive at an ironstone mine at Frodingham, Lincolnshire.

Copper Queen Sampling Practice.—*Mining and Metallurgy* for November publishes a paper by R. W. Prouty and R. T. Green on sampling and estimating ore in the Copper Queen mines, Bisbee, Arizona.

Coal Mine Fires.—At the meeting of the Institution of Mining Engineers held in November, Professor Henry Briggs read a paper discussing the possibility of spontaneous combustion of coal being initiated by the heat produced by crushing.

Disintegration of Coal by Acids.—At the meeting of the Institution of Mining Engineers held in November, Dr. R. Lessing read a paper describing the mining of coal seams by boring holes and forcing in some acid such as sulphurous acid, whereby the earthy matter binding the organic coal is attacked, thus loosening the coal and making it easily removable.

Kent Coalfields.—At the meeting of the Institution of Civil Engineers held on November 21, E. O. Forster Brown read a paper on the underground waters of the Kent coalfield and their incidence in mining development.

Coal Flotation.—At the meeting of the Cleveland Institution of Engineers held on November 13, L. A. Wood read a paper entitled "Some Aspects of Cleaning Coal by Froth Flotation."

Oil-Drilling.—At the meeting of the Institution of Petroleum Technologists held on November 14, Albert Miller read a paper on the Galician-Canadian System of Pole Tool Drilling.

Electrometallurgy of Nickel.—In the *Engineering and Mining Journal-Press* for Nov. 4, J. L. M. Yardley gives some particulars of electric melting and electrolytic refining at the works of the British America Nickel Corporation.

Cyanide Practice.—In the *Engineering and Mining Journal-Press* for November 11, G. J. Young describes the new cyanide plant built for the United Comstock Mines Co., which will treat silver-gold ore at the rate of 2,000 tons per day.

Wilshire Gold Mine.—In the *Engineering and Mining Journal-Press* for November 18, H. W. Turner describes the Wilshire gold mine, Inyo County, California, in which gold and sulphides are found in a quartzite bed of sedimentary origin.

Sierra Leone.—At the meeting of the Geological Society held on November 8, Frank Dixey read a paper on the Geology of Sierra Leone.

Geology of Burma.—In the *Geological Magazine* for November, Dr. L. Dudley Stamp gives an outline of the Tertiary geology of Burma.

New Jersey Zinc Ores.—In *Economic Geology* for November, H. Ries and W. C. Bowen discuss the origin of the zinc ores of Sussex County, New Jersey. The principal zinc minerals of these ores are franklinite, willemite, and zincite.

Cariboo, B.C.—In the November *Bulletin* of the Canadian Institute of Mining and Metallurgy W. L. Uglow gives a geological description of the quartz gold veins of Barkerville, Cariboo district, British Columbia.

Precious Stones.—In *Economic Geology* for November, Sydney H. Ball writes on the geologic and geographic occurrence of precious stones.

RECENT PATENTS PUBLISHED

A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

14,992 of 1921 (188,010). N. TESTRUP and TECHNO-CHEMICAL LABORATORIES, LTD., London, Depositing china-clay in tanks with V bottoms so that the clay with least water in it may be removed continuously from the bottoms.

17,443 of 1921 (186,671). L. WILLIAMS, Newport, Monmouth. Hydraulic rock breaker and coal-mining machine.

17,514 of 1921 (167,464). MANUFACTURES DE PRODUITS CHIMIQUES DU NORD ETABLISSEMENTS KUHLMANN, Paris. In roasting furnaces, improved form of rabbles on rotating vertical shafts.

17,951 of 1921 (186,693). W. E. BLELOCH and H. A. STOCKMAN, Johannesburg. A machine for fine crushing ore, etc., in which crushing blows are given by air-actuated percussive tools.

18,028 of 1921 (166,525). R. ADLER, Carlsbad, Czecho-Slovakia. Counter-current apparatus for leaching ores with or without the addition of gases.

18,318 of 1921 (178,059). RHEINISCH-NASSAUISCHE A.G., W. HOCKS, and G. STOHN, Stolberg, Germany. Improved rabbles for roasting and calcining furnaces.

18,748 of 1921 (166,888). H. HARDY SMITH, Sydney, N.S.W. For the purpose of concentrating oxidized ores, submitting the pulp to the action of sulphuretted hydrogen and carbonic acid, and then passing it to flotation machines.

18,834 of 1921 (187,296). E. I. DU PONT DE NEMOURS & Co., Wilmington, Delaware. An ore concentrating table covered with fabric coated with cellulose ester such as pyroxylin ; this fabric being not so easily worn as, and giving a rougher surface than, materials now used for the purpose.

18,876 of 1921 (187,297). HOHENLOHE-WERKE A.G., and H. SALFELDT, Upper Silesia. Improved ore-concentrating jig.

19,074-5 of 1921 (186,457-8). H. E. FIERZ, Zurich, and H. A. PRAGER, London. Improvements in the method of precipitating nickel from its gaseous carbonyl compound.

19,082 of 1921 (187,313). F. E. ELMORE and the CHEMICAL AND METALLURGICAL CORPORATION, London. Reducing precipitated lead sulphate by mixing with finely divided carbonaceous material and submitting the mixture to heat in the absence of oxidizing gases.

20,857 of 1921 (186,760). A. C. VIVIAN, London, For the purpose of floating oxides such as cassiterite, the addition of weakly acid organic compounds which react on the metallic compound to form a tarry complex helpful in flotation.

22,381 of 1921 (186,497). GENERAL ELECTRIC CO., and C. J. SMITHELLS, London. For the purpose of increasing the life of tungsten filaments, introducing into the metal before drawing an oxide irreducible by hydrogen and a compound of an alkali metal.

24,658 of 1921 (187,111). LA SOCIÉTÉ LE NICKEL, Paris. An improved process for making ingots of pure nickel from crude nickel oxide, which consists in effecting partial reduction of the oxide, powdering and lixiviating the partially reduced product with hydro-chloric and hydro-fluoric acids, drying and agglomerating and calcining the agglomerate so that the remaining oxide burns carbonaceous impurities while being itself reduced, and in the presence of a reducing agent, and if required of a reagent capable of forming a stable sulphide at the temperature of calcination and in the presence of carbon, which reagents cause the later stages of the calcination to complete reduction and effect the removal of sulphur.

25,545 of 1921 (169,703). T. GOLDSCHMIDT A.G., Essen, Germany. A bearing alloy lower in tin than usual, averaging 70 to 75% lead, 15 to 25% antimony, 3 to 6% tin, 1 to 3% nickel, 0·8 to 2·2% copper phosphide.

25,751 of 1921 (187,810). A. NAITO, Tokyo, Japan. For the purpose of agglomerating magnetic iron sands or fine iron ore, mixing the ore with fine coke, loading into heaps, acting on the heaps with some chemical to form an iron compound the influence of which is to cement the iron and coke into lumps and masses.

28,776 of 1921 (170,861). VICTORIA IRON ROLLING, Co., Melbourne. Removing tin from scrap by immersing the latter in a electrolyte in association with an element electro-negative thereto such as copper having a depolarizing substance such as copper oxide in contact therewith in the presence of a solution of caustic soda whereby galvanic action is set up and the metallic tin is dissolved.

31,541 of 1921 (187,869). R. P. WHITELAW, London. Grinding pans for the wet-crushing of ores in stages.

34,281 of 1921 (173,502). C. CLERC and A. NIHOUL, Paris. Improvements in the process of extracting magnesia from dolomite by the action of magnesium chloride, the reaction being as follows: dolomite is burnt at a temperature sufficiently high to make hydration of the magnesia difficult without preventing that of the lime ; the mixture of lime and magnesia obtained is pulverized and purified by causing it to swell and sifting it on a rotary or vibratory sieve ; the finely subdivided mixture of lime and magnesia, in which the lime has been incompletely hydrated and not dissolved, is added gradually to and mixed with a solution containing excess of magnesium chloride so as to precipitate rapidly magnesia partially hydrated and in granular form, which is easy to filter and wash.

34,406 of 1921 (173,236). WESTINGHOUSE LAMP Co., New York, and J. W. MARDEN, Pittsburgh. Improvements in the production of zirconium, titanium, vanadium, tungsten, and similar refractory metals in coherent form.

1,987 and 4,966 of 1922 (174,370 and 177,496). RHENANIA CHEMISCHE FABRIKEN and F. RUSBERG, Mannheim, Germany. Rendering crude phosphate soluble by the action of hydrochloric acid gas.

4,462 of 1922 (187,904). PENNSYLVANIA CRUSHER Co., New York. Improved rotary rolls with toothed surfaces, used for breaking coal, ore, etc.

4,852 of 1922 (187,906). E. B. HACK and G. M. BURT, London. Improved lifting mechanism for holding up stamps free from the cams.

NEW BOOKS, PAMPHLETS, Etc.

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London Wall, E.C. 2.

How to Form a Company. By HERBERT W. JORDAN. Fifteenth Edition. Cloth, octavo, 110 pages. Price 1s. 6d. net. London : Jordan & Sons, Ltd.

The Rescue Man's Manual. By A. B. CLIFFORD. Pamphlet, octavo, 46 pages, illustrated. Price 1s. net. London : The Colliery Guardian Co., Ltd.

Asbestos: A memorandum giving a brief description of the asbestos industry. Compiled by the Natural Resources Intelligence Branch of the Canadian Government. London: The Canadian Trade Commissioner's Office, 73, Basinghall Street.

The Mineral Industry, Vol. XXX, for 1921. Edited by G. A. Roush and Allison Butts. Cloth, octavo, 900 pages, illustrated. Price £2 10s. New York and London: McGraw-Hill Book Co.

The Mexican Year-Book, 1920-1. Edited by R. G. Cleland. Cloth, octavo, 530 pages. Price 35s. net. Los Angeles: The Mexican Year-Book Publishing Co.

Les Progrès de la Metallurgie du Cuivre. By A. Conduché. Octavo, 285 pages. Price 14 francs. Paris: Masson et Cie, and Gauthier Villars et Cie.

Geology of the Tertiary and Quaternary Periods in the North-West part of Peru. By Dr. T. O. Bosworth. Price 45s. net. London: Macmillan & Co., Ltd.

Coal Resources of the Union of South Africa, Vol. I. By W. J. Wybergh. Paper covers, octavo, 140 pages, illustrated. Price 10s. net. Pretoria: The Government Printing and Stationery Office. This is Memoir No. 19 of the Geological Survey of South Africa, and deals with the coalfields of Witbank, Springs, Heidelberg, and the Orange Free State.

Report of the Tin and Tungsten Research Board. Paper covers, octavo, 105 pages. Price 3s. 6d. net. London: His Majesty's Stationery Office. Among other contents, the following papers appear in this pamphlet. Tin Dressing in Cornwall, by F. H. Michell; Microscopic Examination of Veinstones, by E. H. Davison; Use of the Microscope in the Study of Slime Treatment, by H. W. Hutchin; Tungsten Recovery, by H. W. Hutchin; Volatilization of Tin as Chloride, by Sir Thomas Kirke Rose and J. H. Goodchild.

COMPANY REPORTS

Simmer and Jack.—This company belongs to the Consolidated Gold Fields group, and has worked an outcrop gold mine in the eastern part of the central Rand since 1887. During the last few years much of the ore raised has come from ground belonging to the adjoining Simmer Deep and Jupiter. The report for the year ended June 30 last shows that 512,900 tons of ore was mined and sent to the mill, and that 75,523 oz. of gold was extracted by amalgamation and 51,564 oz. by cyaniding. The revenue from the sale of gold was £637,034, of which £99,891 represented premium. The working cost was £597,923, leaving a working profit of £38,803. The revenue per ton was 24s. 10d., of which 3s. 10d. was premium, the cost per ton 23s. 4d., and the profit per ton 1s. 6d. The ore reserve is estimated at 1,224,000 tons averaging 5·4 dwt. per ton over a stoping width of 74 in. Working costs have been substantially reduced since the end of the year under review, and are now under 20s. per ton. New arrangements are being made for hoisting ore. No. 1 shaft has been closed and the ore is now being raised from the Milner shaft of Simmer Deep. No. 2 shaft is to be closed in a short time and ore is to be sent up the Rhodes shaft.

Van Ryn Gold Mines Estates.—This company has worked an outcrop property in the Far East Rand since 1892. Sir George Albu is managing director and E. G. St. John is mine manager. The report for the year ended June 30 last shows that 419,628 tons of ore was mined, and after the removal of waste, 302,728 tons was sent to the stamps. The yield of gold by amalgamation was 61,395 oz., and by cyanide 26,123 oz., making a total of 87,518 oz., or 5·81 dwt. per ton milled. The revenue from the sale of gold was £437,184, of which about £65,000 represented premium. The working cost was £394,824, leaving a working profit of £42,360, and £50,000 has been distributed as dividend, being at the rate of 10%. Owing to the strike early in 1922, the output of ore and gold was considerably below normal, and extra expenditure was also involved. The reorganization after the strike has given such satisfactory results that the present rate of profit is much higher than a year ago. The reserve is estimated at 1,299,617 tons averaging 5·5 dwt. over 47 in. This is an increase as compared with last year of 369,505 tons, and the average content is 0·5 dwt. less. Both changes are due to the possibility of writing back into reserves many blocks of ore that were unpayable in the period of high costs.

Glynn's Lydenburg.—This company has worked gold mines in the Lydenburg district of the Transvaal since 1895. The Transvaal Consolidated Land and Exploration Co. are the secretaries, and the technical control is with the Central Mining-Rand Mines group. The report for the year ended July 31 shows that 46,446 tons of ore was sent to the mill, where 6,074 oz. of gold was extracted by amalgamation and 11,706 oz. by cyaniding, making a total of 17,780 oz. or 7·65 dwt. per ton. The revenue from the sale of this gold, including premium, was £84,540, and the working cost was £73,464, leaving a working profit of £11,075, which is carried forward. As compared with the results for the previous year, the tonnage treated was 6,306 up. The yield per ton was practically the same, and though the output of gold was greater by 2,476 oz., the revenue was £1,818 less, owing to the smaller premium received. It was possible to increase the amount of development done as the supply of native labour was more plentiful, and the reserve was raised from 125,868 tons averaging 7·7 dwt. at the beginning of the year to 162,029 tons averaging 7·8 dwt. at the end. The new vertical circular shaft now being sunk in the southern extension of the Werf Mynpacht has not yet reached the lode. It is worth recording that these mines were not involved in the white labour strike which occurred early in 1922.

Witbank Colliery.—This company has worked collieries in the Middelburg district of the Transvaal since 1896. The control was with Neumann's until a few years ago, when it passed into the hands of the Central Mining-Rand Mines group. The report for the year ended August 31 last shows that the output was considerably restricted owing to a diminished demand, arising partly from the strike at the gold mines and partly from the disappearance of export business. The dispatches from the Witbank mine totalled 424,581 tons and from the Uitspan mine 313,487 tons, making a total of 738,068 tons, as compared with 1,117,680 tons the year before. The profit for the year was £63,890, and £69,454 was distributed as dividend, being at the rate of 20%. Developments continue to disclose coal of the accustomed quality and thickness.

Wankie Colliery.—This company was formed in 1899 to work coal deposits north of the Victoria Falls, Rhodesia. Edmund Davis is chairman and A. R. Thomson is manager. The report for the year ended August 31 last shows that 542,478 tons was raised, of which 72,396 tons was removed as waste on belts and washers, 10,314 tons was used on the spot in the boilers and brickworks, 157,413 tons was employed in coke manufacture, and 302,355 tons was sold. In addition, 109,318 tons of coke was sold. The revenue from the sales of coal, coke, bricks, and fireclay was £313,926, and there was a profit of £75,176. The dividends absorbed £85,199, being at the rate of 15%, less income tax. The reserve proved by development is calculated at 6,888,000 tons, and by means of bores, etc., the amount of coal within two miles is estimated at 53,034,000 tons. As recorded recently, part of the property is being independently developed. The incline shaft on this new colliery has now been completed and its total length to the floor of the coal is 1,354 ft. The vertical depth at this point is 170 ft. below surface, and the thickness of the seam is 28 ft.

Bisichi Tin.—This company was formed in 1910 to acquire alluvial tin properties south-east of Bukeru, on the Bauchi Plateau, Nigeria. In 1920, the properties of the Forum, Ninghi, and Northern Nigerian Trust were absorbed so as to form a compact block more economical to administer. The report now issued covers the year 1921. During this period 164 tons of tin concentrate was won in the Bisichi section, 202 tons in the Forum section, and 46 tons in the Ninghi section, making a total of 412 tons. The financial result, after allowance for depreciation, was an adverse balance of £3,695. Prospecting on E.P.L. 1,060 has given good results, and leases are being applied for to cover the whole area. The company's proved lands are now estimated to contain 10,408 tons of cassiterite.

Tin Fields of Northern Nigeria.—This company was formed in 1909 to work alluvial tin ground in the northern part of the Bauchi Plateau, Nigeria. Dividends were paid for 1919 and 1920, but since then the low price of tin has acted adversely. In April, 1921, the manager, D. Clemens, took over the property on tribute, and in February, 1922, W. R. Norton undertook the work on similar terms. Since then the contract with Mr. Norton has been revised to the company's advantage. The report for the year ended March 31, 1922, shows that the output of tin concentrate was 101 tons, as compared with 85 tons the previous year, and that the financial result was an adverse balance of £1,204. Since the close of the company's financial year, F. M. Lush has been sent out to examine the properties. He reports the discovery of further tin deposits, and for the profitable working of certain deposits he recommends the instalment of gravel pumps.

Rukuba (Nigeria) Tin.—This company was formed in 1912 to work alluvial tin properties in the Rukuba district of the Bauchi Plateau. Owing to the depression in the tin market the properties have been let on tribute. The report for the year ended June 30 last shows that 45 tons of tin concentrate was won. The year ended with an adverse balance of £1,800. New areas have been acquired recently, and a good deal of prospecting has been done. The future policy of the company is now under discussion.

Pahang Consolidated.—This company was formed in 1906 to amalgamate the Pahang Corporation and the Pahang-Kabang Company, and to continue the mining of tin lodes in the State of Pahang, Federated Malay States. The report for the year ended July 31 last shows that 170,900 tons of ore was raised and sent to the mill, where 2,534 tons of tin concentrate was extracted. In addition 167 tons of tin concentrate was won from alluvial and river workings. The figures the year before were 2,269 tons and 143 tons respectively. Towards the end of the year under review it was deemed advisable to shut down some of the outlying mines. The development was curtailed and totalled 28,868 ft. as compared with 42,057 ft. the year before. Of this work most was done on Willink's, Nicholson's, and Bell's lodes. The new pumping plant, for which the company has been waiting for some years, was installed in July, so that it will now be possible to sink below the 600 ft. level. The accounts show an income of £253,081, and an adverse balance of £783. The preference dividend, absorbing £7,000, has been paid for the year under review.

Kampong Kamunting Tin Dredging.—This company was formed in the Federated Malay States in 1913 by Sydney capitalists to work alluvial tin ground at Taiping, Perak. A. W. Freeman is chairman, and C. Nardin is manager. The report for the half-year ended June 30 last shows that the two dredges treated 1,007,000 cu. yd. of ground, for an extraction of 360 tons of tin concentrate, the yield per yard being 0·8 lb. No. 1 dredge was in much better ground than No. 2, the respective yields per yard being 1·07 lb. and 0·52 lb. The revenue from the sale of concentrate was £30,785, and the net profit was £6,925. The dividends absorbed £10,500, the rate being 7½%. It is expected that during the current half-year No. 2 dredge will be in better ground. Recently the operating cost has been lowered substantially.

Asam Kumbang Tin Dredging.—This company was formed in 1920 in the Federated Malay States, as a subsidiary of the Kampong Kamunting mentioned in the preceding paragraph, to acquire alluvial tin ground at Taiping, Perak. The report for the half-year ended June 30 last shows that 641,000 cu. yd. was treated for a yield of 181 tons of tin concentrate. The yield per yard was 0·64 lb. The dredge has been in shallow ground of poorer grade than the average of the property, but it has since arrived at better ground. The accounts show an income of £16,019 and a net profit of £86.

Ulu Yam Tin Dredging.—This company belongs to the Kampong Kamunting group, and was formed under Federated Malay States laws to work alluvial tin ground in Selangor. The dredge started operations early in 1922. The report for the half-year ended June 30 shows that 463,000 cu. yd. was treated, for an extraction of 169 tons of tin concentrate, the yield per yard being 0·82 lb. The revenue was £14,296, and there was a net profit of £199, after allowing for depreciation and paying interest on money advanced.

Burma Corporation.—The yearly report now issued covers the period ended December 31, 1921. During the year 144,089 tons of ore was raised from the mine, averaging 32·8% lead, 20·2% zinc, and 30·5 oz. silver per ton. Of this, 26,554 tons was high-grade ore, averaging 36·5% lead, 21·3% zinc, and 34·4 oz. silver, and the remainder concentrating ore, averaging 32% lead, 19·9% zinc, and 29·7 oz. silver ; part of the high-grade ore was sent

to the smelter direct, and part to the concentrator. The total ore sent to the concentrator was 149,723 tons. The following were the products: 69,517 tons of lead concentrate, averaging 46·9% lead, 20·2% zinc, and 40·6 oz. silver; 7,389 tons of flotation concentrate, averaging 48·8% lead, 16% zinc, and 52·6 oz. silver; 5,108 tons of high-grade slime, averaging 35·6% lead, 17·3% zinc, and 34·2 oz. silver; 9,781 tons of low-grade slime, averaging 22·7% lead, 18·6% zinc, and 24·2 oz. silver; 4,562 tons of zinc concentrate, averaging 43·1% zinc, 11·4% lead, and 17·1 oz. silver; 38,725 tons of mill tailing, averaging 6·9% lead, 16% zinc, and 8·1 oz. silver; and 14,640 oz. of flotation tailing, averaging 7·3% lead, 16·5% zinc, and 6·9 oz. silver. The total material smelted was 158,418 tons averaging 33·7% lead, 12·8% zinc, and 31 oz. silver, for a yield of 46,099 tons of hard lead. At the refinery 47,096 tons of hard lead was treated, yielding 33,193 tons of refined lead, and 3,483,734 oz. silver. The accounts show an income of £1,217,231 (at 1s. 4d. = 1 rupee) from the sale of products, and a net profit of £167,432, which was carried forward. The ore reserve is estimated at 3,954,677 tons of lead-zinc-silver ore, averaging 26·1% lead, 18·4% zinc, and 22·9 oz. silver; and 335,681 tons of copper ore, averaging 11% copper, 12·8% lead, 7·7% zinc, and 23·2 oz. silver. We quote the report by P. E. Marmion on metallurgical progress elsewhere in this issue. More recent information relating to the visit of E. P. Mathewson this year has already appeared in our columns.

Weardale Lead.—This company has operated lead mines in Weardale, County Durham, since 1883. The report for the year ended September 30 last shows that 2,420 tons of lead concentrate and 6,741 tons of fluor-spar were produced. The profit was £12,296, from which has to be deducted £3,286, the adverse balance of the previous year. The shareholders received a dividend of 5%, absorbing £5,875, from which is deducted income tax. Most of the lead concentrate was obtained from the 48 fathom level of the Boltsburn mine, from which 14,980 tons of ore was obtained, yielding 2,369 tons of concentrate. An aerial ropeway has been built from the mines to Eastgate Station, and by its means the cost of transport will be substantially reduced.

Tomboy Gold Mines.—This company belongs to the Exploration Company group, and has worked gold mines above Telluride, Colorado, since 1899. The report for the year ended June 30 last shows that 243,610 tons was mined and sent to the mill; of this total 83,805 tons came from the Argentine group, 150,037 tons from the Montana group, and 9,767 tons from the Virginius property. The yield of bullion by amalgamation, cyanide, and in concentrates was worth $874,582, and the profit was $85,531. After allowance for depreciation and administration, the year ended with a loss of £2,611. Work on the Argentine group has been confined to clearing out the remaining ores and pillars in the upper part of the mine. It is estimated that 255,323 tons remains to be extracted. Lower down the mountain side there are blocks of ore still to be tested with a view of finding portions that will pay. In the Montana group the reserve is estimated at 500,504 tons, and the recent development results have been fairly encouraging. At the Virginius the results have been disappointing, and the limits of the ore-body appear to have been reached in the direction up the mountain. The general policy lately has been to mine as much ore as possible in order to keep down the cost per ton, and during the past year the tonnage was the highest on record and the costs the lowest. The yield per ton has been only $4·14 and the cost per ton was $3·80.

El Oro Mining and Railway.—This company belongs to the Exploration Company group, and has worked a gold mine at El Oro, Mexico, since 1899. The report for the year ended June 30 last shows that operations have been carried on continuously without political or labour obstruction, and that the output of ore was higher than ever before. The grade of the ore treated, however, continues to be low, and development has not disclosed any ore of higher grade. During the year 401,840 tons of ore was sent to the mill, and gold and silver bullion valued at £538,250 was extracted. The railway receipts were £70,641, against an expenditure of £22,716. The profit, after allowance for depreciation and taxes, was £83,602, out of which £57,375 is to be distributed as dividend, being at the rate of 5% tax paid. The working costs were substantially reduced during the year. The ore reserve is estimated at 339,687 tons, averaging $5·23 gold and 1·73 oz. silver. The subsidiary company, organized for exploration purposes, has been developing the La Noria silver mine in the State of Zacatecas, and the results have been gratifying. Further development is being undertaken.

Frontino and Bolivia Gold.—This company has worked gold mines in Colombia since 1864. Pellew-Harvey & Co., are the consulting engineers, and John Reed is the superintendent. The report for the year ended June 30 last shows that 30,531 tons of ore was raised and that, after sorting, 24,480 tons was sent to the mill. The yield of gold by amalgamation was 16,802 oz.; 514 oz. was obtained by amalgamation and cyanide from concentrates; 2,677 oz. was extracted by cyanide from 12,587 tons of sand; 1,594 oz. was extracted by cyanide from 11,289 tons of slime; making a total, with slags and residues, of 21,558 oz. The yield per ton was £3 16s. 1d. at par. The balance of profit was £17,475, out of which £3,913 has been distributed as debenture interest, £2,339 as preference dividend, and £8,831 as ordinary dividend, the rate being 5%. The developments have continued satisfactory on the whole, and the reserve stands at 53,000 tons averaging 17 dwt. per ton, as compared with 52,100 tons averaging 15·7 dwt. the year before. The subsidiary company, the Marmajito, commenced production in June. The mines have been troubled for some time recently with scarcity of labour.

Chemical and Metallurgical Corporation.—This company was formed in 1919 to acquire the Elmore acid-brine process for separating the metals from complex lead-silver-zinc sulphides. Subsequently interest was taken in the Francois cementation process. The report for the year 1921 shows that a plant with a capacity of 35 tons per day is being erected at Stratford, London, E., where the Elmore process is to be tested on behalf of the Burma and Zinc Corporations. The company has recently acquired an interest in the Diehl process for recovering zinc, lead, and silver from zinc ores and from zinciferous slags from lead and copper smelting furnaces. The company has an interest in a gas-pressure regulator used on the Continent, and a company has been formed to introduce it into this country. The company has not yet arrived at a profit-earning stage, so no profit and loss account is presented.

CHINESE ENGINEERING AND MINING CO., LTD.

Directors : W. F. Turner (*Chairman*), F. Cattier, Edmund Davis, E. de Wouters, E. Francqui, L. Jadot, Col. H. A. Micklem, Lord Southborough. *Agent and General Manager in China :* Major Walter Nathan. *Secretary :* A. W. Berry. *Office :* 22, Austin Friars, London, E.C. 2. *Formed* 1912. *Capital issued :* £1,400,000 ; debentures, £984,000.

Business : Operates coal mines in Chi-li Province, North China, the sales being in the hands of the Kailan Mining Administration.

The tenth annual ordinary general meeting of the Chinese Engineering and Mining Co., Ltd., was held on December 11, at Winchester House, London, E.C., Mr. W. F. Turner (Chairman of the company) presiding.

The Secretary (Mr. Alfred W. Berry) having read the notice convening the meeting and the auditors' report,

The Chairman said : The report and accounts for the year ended June 30 last, which we submit to you to-day, will have caused some disappointment to you, as they have done to the board. It arises from circumstances beyond the control of those who have the management of our affairs in China, as I will explain later. The net result is that we are able to pay a balance dividend of 3½%, making 13½% for the year, free of income tax, which is equal to 18% less tax, a substantial result when considered by itself and apart from our achievements in previous years.

The net profit of the Kailan Mining Administration, after providing for interest on the 6% Kailan bonds, redemption of bonds for the year, reserve for depreciation, and the proportion to which the Chihli Government is entitled, was $4,593,784.

Our share of the profit amounts to $2,528,683, against $3,850,013 in the preceding year. The credit to our profit and loss account, including interest in China, and after making certain adjustments, is £352,295, the average rate of exchange for our remittances for the year being 2s. 5⅛d. per dollar. Interest in Europe amounts to £25,734, against £72,221 in the preceding year, the reduction being caused by the fact that the funds in hand were considerably less, and the rates of interest obtainable for money on deposit having been almost nominal. There is a profit of £10,804 on the sale of 5% National War Bonds. The agency fee and other receipts amount to £6,333. The total to the credit of the profit and loss account is, therefore, £395,168. The expenses in Europe show a slight increase, and the debit on the exchange account also shows an increase. The net balance carried down is £354,686.

The profit and loss account shows the disposal of the balance at June 30, 1921, in accordance with the resolutions of the last general meeting. I need not recapitulate the items. The balance brought forward from that year was £19,987, which makes a total credit to the account at June 30, 1922, of £374,674. Of this income tax absorbs £155,243 and corporation profits tax is estimated at £21,300 ; the interim dividend of 10%, free of tax, paid on May 15 last, amounted to £140,000, which leaves an available balance carried to the balance sheet of £58,130. It is proposed to write off the balance of the cost of share warrants to bearer, etc., in connexion with the increase of capital which took place two years ago, namely, £1,351. The further remuneration to which the directors are entitled amounts to £1,819. The balance dividend of 3½%, free of tax, which we propose to declare to-day, amounts to £49,000, which will leave a balance to be carried forward to the current year of £5,959.

As regards the balance sheet, there is no new feature of interest. The creditors—£95,733—consisting mainly of income tax, unpaid dividends and debenture interest, show a reduction of about £30,000 compared with the preceding year. The reserve account for redemption of debentures has been increased by the annual drawing of £24,000, making a total of £228,000. The cash stood at £350,000. The debtors consist chiefly of the Kailan Mining Administration current accounts, including the balance of our share of profits to June 30 last. The other items on the credit side of the balance sheet do not require any comment.

You will notice that the auditors in their report state that they have received all the information and explanations that they have required, subject to the production of the usual inventories of stocks of the Kailan Mining Administration at June 30, 1922, which are in transit. These inventories have been prepared in the usual course, but apparently by some oversight were not despatched as promptly as they should have been. They have now arrived and are found to be in order.

The report states that the sales of coal for the year amounted to 3,536,000 tons, a reduction of 240,000 tons compared with those of the preceding year. You may recollect that an increase, not a decrease, of sales, was expected for the year with which we are dealing. It is therefore interesting to follow the course of the sales throughout the year. The expected increase began in the first week of the year and continued week after week almost without a check until it reached its maximum in the week ended February 4, 1922, the increase up to that date being over 300,000 tons. The profits up to that time were quite satisfactory. The sales then began to decline steadily, until in the middle of May the increase over the preceding year had disappeared, the lowest point being reached in the week ended May 20, when the sales recorded were only 18,000 tons. The sales varied from about 25,000 to 35,000 tons per week up to the end of the year, the consequence being that instead of the large increase which was shown in the middle of February, there was a deficit, as already stated, of 240,000 tons. The reduction in sales and the reduction in the profits of the Kailan Mining Administration, compared with those of the preceding year, is stated in the directors' report to be due chiefly to the disturbed political conditions in Northern China, which culminated in military operations during the months of March and April last in the Province of Chihli, where the Kailan mines are situated. It is not due to any falling off in the demand for our coal.

The first sign of trouble, so far as the business of the Kailan Mining Administration is concerned, seems to have been in the month of January last,

when a large part of the rolling stock of the Pekin-Moukden Railway, on which line the Kaiping mines, the port of Chinwangtao and the great depot of Tientsin are situated, was held up at Moukden (the capital of Manchuria, which lies to the north of the Province of Chihli) in readiness for future eventualities. From that time onwards the business suffered from the restriction of the facilities for the transport of the coal from the mines, and the deliveries of coal began to decline.

I will try to state in the briefest terms what happened. During the month of April the Manchurian or Northern Forces were moved southwards along the Pekin-Mukden Railway into the Province of Chihli with the object of attacking the Southern Forces which were disposed approximately on a line south-west and south of Pekin and Tientsin respectively. The Northern Troops were defeated in a general engagement and a retreat began along the railway line towards Shanhaikwan on the way to Mukden. This necessarily meant that large bodies of the defeated soldiery passed through our Kaiping mines area and the port of Chinwangtao, which is the outlet for our overseas trade. The railway became completely blocked, work at Chinwangtao was suspended, there was general confusion, and, as I have already mentioned, the sales fill to an almost negligible figure. Emergency measures had to be taken for the protection of the mines by such small forces as could be obtained from elsewhere or organized on the spot. Negotiations were opened up with the chiefs of the rival forces with satisfactory results. The Northern Forces withdrew to Shanhaikwan, the first station beyond our point of shipment at Chinwangtao, and the situation began slowly to return towards the normal. The reduction in the sales is only one element in the losses, direct and indirect, arising from these disturbances. How serious they have been is indicated in the statement of accounts before us, but it is quite possible to exaggerate the significance of them. This is the first time in a period of twenty years that our operations have met with serious interference. It is to be remembered that during these troubled months, except for a fortnight in the month of May, the output was maintained at a high figure. The acting general manager wrote afterwards that neither he nor the engineer-in-chief at any stage considered that there was danger of any serious loss or damage (that is, physical loss or damage) in the mines area provided that panic among the employees could be prevented. That was done, and I ought to say here that the engineer-in-chief displayed great energy, ability, and initiative in dealing successfully, as he did, with the difficult situation. The general behaviour of the Administration's employees in the mines area throughout the crisis is reported to have been admirable. None of the employees or the members of their families appears to have suffered in any way except through unavoidable anxiety or inconvenience, and there does not appear to have been any loss of, or damage to, property of any kind.

Unfortunately, the Northern Forces in their retreat took with them all the railway rolling stock on which they could lay their hands, and the negotiations which have been undertaken by the Chinese Government for the return of it seem to have been without result. The position has, however, been greatly eased for the Pekin-Mukden railway by the use of cars from other lines.

The general situation, although greatly improved, is not yet normal. It has been rendered more difficult, and the sales have been diminished by a strike which broke out at certain of the mines in the last week of October. The trouble seems to have originated in the workshops of the Pekin-Mukden Railway at Tongshan and Shanhaikwan, demands being made in regard to wages and leave, some of which appear to have been of a preposterous nature. The strike was settled by apparently large concessions being made on the part of the Railway. Similar demands were thereupon made by our workmen at Chinwangtao and at some of the mines. The management, recognizing that there had been an increase in the cost of living, made an offer of increased wages in order to meet what they regarded as a reasonable grievance. Though the offer appeared to have been acceptable to the majority of workers, owing to the action of the extremists the strike continued, and a serious situation developed. A considerable force of Chinese police was obtained from Tientsin to deal with the strikers, and a party of British troops was sent for the protection of the European staff and their families. Ultimately order was restored and the strike ended after lasting about 4 weeks by the acceptance of the terms which had been offered by the management to the men at the outset.

Most of this information has reached us within the last few days and it must be read in conjunction with the statement in the directors' report relating to the results likely to be obtained for the current year.

I have dealt concisely but frankly with these two troubled periods, the one in the financial year to June 30 last, the other in the year now current, because my colleagues and I feel that it is our duty to give you as accurate a view as we can of the course of affairs. Let us turn for a moment, in conclusion, to the other side of the picture.

I have already said that we are behind with our sales for the current year, but we still have over six months to run. We have a very large stock of coal ready at the mines and depots. The mines are developed for the production of about four and a half million tons per annum, which can be increased to double that quantity if need be. The coal in sight amounted at June 30 last in round figures to twenty-four million tons. The demand for our coal continues, and, given normal conditions, it should increase year by year. The doubling of the railway from the mines to the port of Chinwangtao, to which I referred last year, has of course been delayed by the disturbances of last spring, but the work is going on and is expected to be completed by the end of next year. This will greatly facilitate the delivery of coal from the mines. All that is required therefore is an adequate supply of rolling stock on the part of the railway to enable us to keep pace with the increasing demand for our coal and to ensure the future prosperity of our enterprise in which our confidence is unabated.

I now move "That the directors' report and accounts to June 30, 1922, be and they are hereby received and adopted, and that a final dividend be declared of $3\frac{1}{2}\%$, free of income tax, making $13\frac{1}{2}\%$ for the year, free of income tax, payable on December 12, 1922."

Mr. Félicien Cattier seconded the resolution, which was carried unanimously.

CHEMICAL AND METALLURGICAL CORPORATION, LTD.

Directors : Herbert Guedalla (*Chairman*), A. Stanley Elmore (*Managing Director*), M. Atkinson Adam, J. A. Agnew, F. W. Baker, Walter McDermott. *Technical Adviser :* F. E. Elmore. *Secretary :* J. A. Stocker. *Office :* 701, Salisbury House, London, E.C. 2. *Formed* 1919. *Capital :* £1,200,000.

Business : The development and finance of new processes; particularly the Elmore mixed-sulphide process and the Francois cementation process.

The second ordinary general meeting of the Chemical and Metallurgical Corporation, Ltd., was held on November 24, at Winchester House, London, E.C., Mr. Herbert Guedalla (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1921, said that in addition to the Elmore and Francois processes, they had also taken a small interest in the Diehl process, which was a process for the recovery of zinc, lead, and silver from zinciferous ores or zinciferous slags from lead or copper smelting furnaces, of which large accumulations existed in various parts of the world. These ores and slags had so far been of little or no value, but if they were treated by this process they should give very good returns. Large-scale tests extending over several weeks had been carried out, under the most minute supervision of experts, on more than 5,000 tons of the material and a full-sized working plant, with the most satisfactory results. In these tests 5,460 tons of ores and fluxes were smelted, producing 2,414 tons of pig iron, 1,224 tons of slag, 135 tons of flue dust, 103 tons of high-grade zinc products, and approximately 11,000,000 cubic metres of blast furnace gas suitable for power production. Experts thought very highly of this process, and negotiations were now being conducted with interested parties with a view to the formation of a company for the commercial development of this important metallurgical invention.

Another investment concerned a gas-pressure regulator. A company had been formed to deal with the business and to introduce the invention into this country. The installations on the Continent had produced the economical results which had been claimed for them, and in normal times the installation of these small plants in this country would doubtless appeal to the works to which they could be of use.

The exploitation of the Elmore process from the technical side had made considerable and satisfactory progress, and the unavoidable delays had been utilized in the experimental works in improving the different items of plant with very great success, and in several directions notable improvements had been made in the process in order to make its application easier in widely different conditions, both climatic and metallurgical, and also in the direction of simplification of operation, and a long step had been taken in rendering the plant almost automatic so far as some of the important stages were concerned. The possibility of the utilization of some of the by-products had received careful consideration, and this might prove to be of great value in the process. During the work performed in perfecting the plant, it had become obvious that several items of the plant had application to other chemical and metallurgical processes. These were the subject of separate patents, and they had been approached by several important concerns with a view to the use of the plant and also to take up and use it for yet other outside applications.

During the whole of this year long negotiations had been proceeding with the Burma Corporation. These were now concluded, with the result that for the moment they had deferred the idea of erecting works on the River Tees, and it was perhaps fortunate that this had happened, because the cost of such erection had been declining during this period. They had arrived at an agreement with the Burma and the Zinc Corporations under which the process would be tried out in this country on a commercial scale; in fact, on such a scale as would satisfy their engineers, and each of these companies would, under the observation of their own experts, have some hundreds of tons of their ore put through this plant. Their present plant was capable of treating about 5½ tons per day, and there was no difficulty in treating these ores, but the new plant would treat about 6 or 7 times this quantity, and naturally they would exercise the greatest care in attaining the successful results which they had no doubt would be obtained. For this purpose they had taken, on very reasonable terms, a site at Stratford and had a satisfactory agreement with their neighbours for the supply of acid and other facilities, which would save a very large initial outlay. The work on this plant was proceeding as quickly as possible, and it was being directed by a committee on which both the Burma Corporation and the Zinc Corporation were represented. They hoped in the course of the next few months to begin these large-scale tests. There was a possibility that after these tests had been completed these works could be expanded into an important profit-earning plant, and thus they would be enabled to carry out on a commercial scale here the production of several lead and zinc products that had great value by reason of the purity with which they could be produced in the ordinary operation of the process. Particularly was this so in the case of the zinc residues remaining after they had taken out the lead and silver.

During the year the process had been seen at work by a number of the most eminent metallurgists, and in every case they had given favourable opinions. Criticism of a process such as their's was often extremely useful, and that which had been passed had certainly been most helpful. It drew attention to the relative great importance in some cases of the silver recovery, and led their staff to the long researches which ended in the highly satisfactory recovery of the silver as a part of the main process. In the same way the not quite so friendly criticism, which suggested as a serious defect the possible difficulty of converting the lead sulphate, which was the end product of the process, into metallic lead, was the spur which brought out the method they had devised for making their end product metallic lead, instead of lead sulphate.

Mr. F. W. Baker seconded the resolution, and it was carried unanimously.

NEW MODDERFONTEIN GOLD MINING CO., LTD.

Directors: Sir Evelyn Wallers, K.B.E. (*Chairman*), Sir H. Ross Skinner, F. R. Phillips, R. W. Ffennell, S. C. Black, C. S. Goldman, J. G. Currey, W. T. Graham. *Secretaries:* Rand Mines, Ltd. *Head Office:* Johannesburg. *London Office:* 1, London Wall Buildings, E.C. 2. *Formed* 1888. *Capital:* £1,400,000 in shares of 10s. each.

Business: Operates a gold mine in the Far East Rand.

The twenty-fifth ordinary general meeting of the New Modderfontein Gold Mining Co., Ltd., was held in Johannesburg on November 7, Sir Evelyn Wallers (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said shareholders would agree that the position reflected was most satisfactory, especially when due regard was paid to the unexpected difficulties caused by the protracted strike of January-March last, and the subsequent revolt, with all its potentialities of disaster. In this connexion, the board wished to express its keen appreciation of the services rendered by the manager and his staff, who, at considerable personal risk, remained at their posts and safeguarded the company's interests during this critical period.

The working profit for the year was £1,167,265, a decrease of £531,787 below last year's record figure. This shortfall was partly due to a drop of 136,000 tons in the tonnage milled, consequent on the stoppage of operations during the strike, but was mainly due to the heavy fall in the price of gold. The average price obtained during the year was £4 19s. 11d. per fine ounce, as compared with £5 12s. 7d. for 1920-1921, the revenue accruing from the enhanced price of gold above standard value being £359,583, as against £751,427 for the previous year. 947,000 tons of ore were milled, yielding 9·499 dwt. per ton, a decrease in grade of rather less than a quarter of a dwt. This, for the reasons stated in his last year's speech, was a desirable feature. The metallurgical practice at the mine continued to be most excellent, 449,768 fine ounces being recovered during the year, with an average total extraction of 98·6%. Certain small additions were sanctioned at the eastern reduction works, which would further improve the efficiency of the ore treatment plant. Heavy and unavoidable expenditure was necessarily incurred during the strike, but, in spite of this, the average working costs for the year showed a decrease of 7d. per ton milled. This was almost entirely due to the reorganization effected after the strike, in consequence of which working costs for June last were reduced to 18s. 6d. per ton milled, as compared with the average of 23s. 5d. for the year 1920-1921.

The total profit for the year was £1,184,528 14s. 11d. The balance to the credit of appropriation account at the commencement of the period was £306,848 10s. 1d., which, with the foregoing profit and £950 12s. 7d. in respect of forfeited dividends, gave a total of £1,492,327 17s. 7d. for disposal. Out of this sum Dividends Nos. 31 and 32 had been paid, absorbing £980,000; £158,907 had been paid as Government Taxes; £18,824 had been spent on capital account; and £89,057 had been expended in connexion with the purchase of ex-enemy shares.

Development operations were pushed ahead vigorously during the first half of the year, an average monthly footage of 2,339 ft. being accomplished, but were practically at a standstill during the strike and the subsequent period of reorganization. As a result, more than four months' development was lost, with, of course, a corresponding decrease in the tonnage of payable ore developed, which totalled 975,700 tons, of an average value of 10·7 dwt. The total footage accomplished during the year was 17,677 ft., of which approximately 11,200 ft. developed ore, the remaining footage being necessary dead work in connection with the handling of ore. The outstanding feature of the year's work was that, broadly speaking, good values were encountered uniformly throughout the property all along the stretch of two miles from the eastern to the western boundary.

The ore reserves, as recalculated at June 30 last, stood at 8,577,600 tons, of a value of 8·6 dwt. over 66 in., including 393,600 tons of 6·6 dwt. value in the form of shaft pillars, which were temporarily unavailable. The increase of 0·2 dwt. in the value was due to a reduction of two inches in the estimated stoping width, which reduction was also the chief cause of the decrease of 307,000 tons in the total tonnage. Owing to the restricted development to which he had already referred, they were unable to make good this decrease in tonnage during the period under review, but there should be a considerable improvement in this regard during the current year. The reduction in the stoping width was a direct consequence of the cleaner mining and narrower stoping which was now in evidence underground, as a result of the continued efforts of the management in this direction.

The mine had now got back into its normal stride, and a substantial improvement was noticeable in the efficiency of the white labour force. The native labour contingent was seriously depleted during the strike, but the mine was a popular one with the natives, who returned rapidly; in consequence, the position in this connexion soon resumed normal. They were continuing to explore every possible avenue of further economy and efficiency in their mining and metallurgical methods, and in the consumption of stores and materials.

During the four months which had elapsed since the close of the last financial year, marked progress had been made, and the monthly tonnage milled had been steady at the excellent level of about 110,000 tons. Working costs had shown a most encouraging continued decrease, the figures for the respective months being: July, 17s. 9·6d.; August, 17s. 4d.; September, 16s. 11·7d.; and October, 16s. 9·6d. per ton milled, as compared with last year's average of 22s. 10d. The working profits had, as a result, shown gratifying increases, being: July, £127,933; August, £140,603; September, £144,917; and October, £149,671. Development work had been carried out at the rate of over 2,000 ft. per month, the reef disclosures being excellent. The two headings which were being driven from the

southern boundary (by the courtesy of the Modder Deep Company), immediately to the south of the proposed new shaft were also proving good values.

Preparations for the sand-filling scheme in the upper levels of the north-eastern section of the mine, referred to in his last speech, were delayed by the strike, but were now completed, and filling had been commenced.

A comprehensive scheme had been adopted for the exploitation of the ore in the lower levels of the mine, that was, below the 14th level. For this purpose it was proposed to sink a circular shaft in the south-western portion of the property. This shaft would cut the reef at an estimated depth of about 2,700 ft. At the same time, two inclines would be sunk on the reef from the 14th level, the eastern starting from the bottom of the present circular shaft, and the western in the line of section of No. 2 incline, furnishing an early connexion with the new shaft. This lay-out, when completed, would provide favourable means of speedily and economically exploring the remaining undeveloped area of the mine. Ore hoisted through the new shaft would be sent to the existing mills by surface haulages. The estimated cost of the work contemplated was approximately £300,000, which expenditure would be spread over a period of five years. The board was satisfied that, in this way, they would be able to maintain the mine in its present advantageous position as regards ore reserves, and, when the upper levels were exhausted, treat the ore in the lower levels of the mine with the maximum efficiency and economy. In view of the present satisfactory condition of the mine as regards development and reserves, there was no need to commence shaft-sinking operations until about June next. In the meantime, preliminary work was being carried out to enable the actual sinking, when it was started, to be completed as cheaply and as rapidly as possible.

He was glad to be able to report that the matter of ex-enemy shares, to which reference had been made on previous occasions, had been finally settled on a satisfactory basis. During May, the Central Mining and Investment Corporation, Ltd., were successful in purchasing as one transaction from the Custodian of Enemy Property the entire holdings of ex-enemy shares controlled by him in the various mining companies under that Corporation's administration. Included in this purchase were the ex-enemy shares of their company, and the Central Mining and Investment Corporation at once offered to shareholders the opportunity of acquiring one of these shares for every five shares held, at the price paid the Custodian, namely, 66s. 3d. per share. The response to this offer was considerably short of what one would have anticipated, only 383,688 shares being taken up by shareholders. The company had paid its proportion of the legal and other expenses involved in this transaction, including a commission of 5% to the Corporation, and, in view of the magnitude and responsibility of the financial arrangements involved, the completion of this long outstanding and very important matter would commend itself as having been effected in a very satisfactory way.

Mr. S. C. Black seconded the resolution, and it was carried unanimously.

NOURSE MINES, LTD.

Directors : E. G. Izod (*Chairman*), Sir Evelyn Wallers, F. Raleigh, W. T. Graham, H. Nourse, S. C. Black, A. F. Mullins, J. L. Jourdain. *Secretaries :* Rand Mines, Ltd. *Head Office :* Johannesburg. *London Office :* 1, London Wall Buildings, E.C. 2. *Formed* 1894 as Nourse Deep. *Capital :* £827,821.

Business : Operates a gold mine in the Central Rand.

The twenty-sixth Ordinary General Meeting of Nourse Mines, Ltd., was held in Johannesburg on November 7, Mr. E. G. Izod (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said that the tonnage of ore milled for the year was the lowest recorded for fourteen years, and was, of course, very considerably affected by the strike. During January, February and March they made heavy losses, the loss for these three months, including the strike expenditure, being slightly over £40,000. The grade for the past year at 6.548 dwt. per ton milled remained about normal, although slightly higher than in the previous year. As was only to be expected, the development programme was considerably curtailed, the footage being 6,300 ft. less than for the previous year. In spite of this reduced footage, and principally on account of the considerably lesser tonnage mined, the re-valuation of the ore reserves showed little change in the position, there being a small increase in the tonnage, with the value unchanged at 6·9 dwt. The actual profit earned was £22,376. They distributed two dividends totalling 6¼%, absorbing £50,698.

There had been a continual improvement in efficiency during the current year, especially in the actual mining side, which was reflected not only in a great improvement in the monthly milled tonnage but in a marked decrease in the costs per ton milled. There was no difficulty now in supplying the plant with a maximum tonnage. The tons milled for the first three months of the current year were 141,600, fr an average of 47,200 per month. Working costs oor the three months, July to September inclusive, were 24s. 6·5d. per ton milled. October was even better with 49,200 tons crushed at a cost of 22s. 8·1d. per ton milled. These figures showed a very satisfactory reduction when compared with the figure of 31s. 5d., being the cost per ton milled for the period July to December, 1921.

The profit earned for the first four months was £41,267, and, when it was remembered that the price realized for the gold had fallen very considerably since last year, it having been taken for the current year to date at approximately 91s., it would be seen that the much-needed rearrangement of underground work they had now been able to bring about had entirely altered the outlook of the company.

Mr. S. C. Black seconded the resolution and it was carried unanimously.

SOUTH-WEST AFRICA CO., LTD.

Directors: Edmund Davis (*Chairman*), Sir Henry Birchenough, D. O. Malcolm, F. Eckstein, R. Philipson Stow, Admiral Sir E. J. W. Slade. *Secretary:* C. Launspach. *Office:* 1, London Wall Buildings, London, E.C. 2. *Formed* 1892. *Capital:* £561,632.

Business: The development of the South-West Africa Protectorate.

The annual general meeting of shareholders of the South-West Africa Company, Ltd., was held on December 6 at Winchester House, London, E.C., Mr. Edmund Davis (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 18 months to June 30 last, said that the bulk of the ex-enemy shares had been purchased and cancelled. During the period under review, they had, on account of the necessity of prospecting, to incur very heavy expenditure in South-West Africa, an expenditure warranted by the mineralization of the territory covered by their original concession. As far as the future was concerned, South-West Africa should, with the improvement of general conditions and with an enlightened Government, show considerable progress, and they were doing all they could to assist in the development of the territory. Not very long ago they offered the Government the full use of their services for the raising of a loan, and made arrangements to submit a firm offer, open for several days. Advantage was not taken of the proposal, no doubt due to the expected general improvement in trade and the more satisfactory financial position of the country, which was estimated to show a surplus for the current year of about £145,000. The Government was constructing harbour works at Walvis Bay at a cost of about £550,000, and private enterprise would probably erect cold storage and meat export works at the port, which should be of great assistance to the Colony and result in additions to the white population, which it was pleasing to note already included 10,673 British subjects, compared with 7,855 German. They were doing their share towards the development of the country, and were boring in two different localities on the recommendation of their general representative (Mr. T. Toennesen), who should be here within a few days. He had had, unfortunately, to leave the Colony temporarily on account of hardships suffered during a lengthy trip in the northern part of South-West Africa and the southern portion of Angola. Their general representative originally went to South-West Africa in 1899, and was, in their opinion, one of the best authorities on its resources, and great weight was attached to his views as to its future. It was interesting to note that the Harbour Advisory Engineer, in reporting to the Union Government on the Walvis Bay Harbour Scheme, had particularly referred to Mr. Toennesen's views, he having reported at some length on this subject to the Government.

Mr. D. O. Malcolm seconded the resolution, and it was carried unanimously.

WITBANK COLLIERY, LIMITED.

(Incorporated in the Transvaal.)

EXTRACTED FROM THE ANNUAL REPORT for the Year ended August 31, 1922.

Issued Capital, £350,000 in 350,000 Shares of £1 each.

Directorate: Sir H. Ross Skinner, Kt., M.Inst.C.E. (*Chairman*), Sir Evelyn Wallers, K.B.E., E. G. Izod, M.B.E. (*Managing Director*), Major C. S. Goldman, P. Dreyfus, Sir Abe Bailey, Bart., K.C.M.G., M.L.A., Sir Julius Jeppe, Kt., C.B.E., W. J. Gau.

		£ s. d.
Total profit for the year		63,890 19 7
Balance unappropriated at August 31, 1921		108,701 18 4
Making a total of		172,592 17 11
This amount has been dealt with as follows :—		
Net expenditure on Capital Account, viz., Equipment	£1,639 18 10	
Purchase of 5,453 ex-Enemy shares at 37s. per share	10,088 1 0	
	£11,727 19 10	
Less Sales of Township Stands and Freehold Property, etc.	3,336 7 3	
	8,391 12 7	
Expenses in connexion with Purchase of ex-Enemy Shares	504 8 0	
Government Taxes	7,591 16 0	
		16,487 16 7
		£156,105 1 4
Dividends declared during the year: No. 34 of 10% on 350,000 £1 shares, declared February 14, 1922, and No. 35 of 10% on 344,547 shares, declared August 16, 1922		69,454 14 0
Leaving a balance unappropriated of		£86,650 7 4

The export trade, which is vital to the coal industry of the Transvaal, has been very seriously restricted throughout the period under review by the effective competition of British coal which, on the termination of the coal strike in Britain, re-entered eastern ports. The internal trade was dislocated during the first three months of the current year by the strike. Despatches from the mine accordingly fell from the record of 1,117,680 tons, established last year, to 738,068 tons, and the profit shows a decline of £92,061 9s. 8d.

Development continues to disclose coal seams of satisfactory quality and thickness in both sections of the mine.

The underground workings are in first-class condition, and machinery and plant have been maintained in good working order.

The full Report and Accounts may be obtained from the London Secretaries, A. Moir & Co., 1, London Wall Buildings, London, E.C. 2.

WANKIE COLLIERY CO., LTD.

Directors: Edmund Davis (*Chairman and Managing Director*), Sir Henry Birchenough, W. Rhodes, D. N. Shaw, H. L. Stokes. *General Manager in Rhodesia:* A. R. Thomson. *Secretary:* A. W. Bird. *Office:* 2, London Wall Buildings, London, E.C. 2. *Formed* 1899. *Capital issued:* £567,331 10s. in 10s. shares; debentures £44,000.

Business: Operates a colliery in North-Western Rhodesia.

The eighth ordinary general meeting of the Wankie Colliery Company, Ltd., was held on November 28 at Winchester House, London, E.C., Mr. Edmund Davis (Chairman and managing director) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended August 31 last, said that he would congratulate the shareholders on the satisfactory position of the undertaking. The proceeds derived from the sale of coal, coke, firebricks, and fireclay amounted to £313,926, a reduction of £33,286 on last year's figures. This fall in the receipts, however, was more than offset by reduced working costs, which for the year amounted to £180,944, as compared with £227,755 last year, a decrease of £46,811. During the year they sold 302,355 tons of coal and 109,318 tons of coke. In the previous year they sold 314,124 tons of coal and 123,135 tons of coke, the trade for the year covered by the accounts showing a decrease of 11,769 tons of coal and 13,817 tons of coke, as compared with the previous year. The result for the year was a net profit of £75,176, compared with £69,986 last year. It was proposed to declare that day a dividend of 15%, and as they had already paid two interim dividends each of 5% on account of the year's profits, there would be paid on the passing of the necessary resolution a further and final dividend of 5%, less income-tax, which would absorb £28,366, and the balance, £19,449, would be carried forward to the current year.

He considered it necessary to refer to the attitude the Rhodesia Chamber of Mines had taken up in connection with the affairs of their company since the latter part of the year 1918, when a committee of inquiry was sent to the colliery to investigate the complaints of the fuel consumers and the shortage of supplies. They then pointed out that the trouble which had arisen was not in any way due to lack of equipment at the colliery, but to shortage of labour and a totally inadequate truck supply. Desiring to meet the views of the public, they acceded to the committee's request to open up a new colliery. All the preliminary work had been carried out at a cost to date of £25,519. The sales of coal to the mines which pressed for the opening out and equipment of a new colliery, were less now than they were in 1918, being 73,152 tons for the year ended December 31, 1921, as compared with 74,737 tons for the year ended December 31, 1918. Their total coal sales for the past five financial years proved that the demand for a new colliery was never justified. The mining companies in Southern Rhodesia purchased 74,737 tons of coal in 1918, 69,722 tons in 1919, 79,365 tons in 1920, and 86,284 tons in 1921. The last communication they had from the Rhodesia Chamber of Mines was dated Bulawayo, July 13, 1922, in which they stated that considerable relief could be granted to mines in Rhodesia by a reduction in the cost of articles required for daily consumption, such as coal and coke, though the average price of coal at the pit's mouth at the colliery, according to this communication was 11s. 5d. per ton in 1921. It would be better for the mining companies to look in other directions for reductions in their working costs rather than to expect the company to lower the price of coal at Wankie. This the managements would better realize when he pointed out that a reduction of 1s. per ton in the price of coal would only lead to the following reduction in working costs per ton of ore treated by the various companies:—

Mine.	*Pence per Ton of Ore.*
Shamva	0·38
Cam and Motor	0·82
Gaika	1·12
Falcon	1·53
Globe and Phœnix ..	2·90

In the Rhodesia Chamber of Mines letter, to which reference had been made, the pit's mouth price of their coal was compared with that in the Transvaal. Such a comparison was not of much value, the question of cost price entirely depending on local conditions and tonnages dealt with. In the Transvaal power was principally supplied to the Rand by the Victoria Falls and Transvaal Power Company, which used over 1,250,000 tons of coal per annum for generating purposes, whereas the whole of Southern Rhodesia, the railways excepted, only took 116,636 tons of Wankie coal during the financial year covered by the present accounts. Of course, it would not be difficult to refer to the cost of producing coal in the Transvaal and compare it with other countries, but to do so would be of but little value. He regretted to have found it necessary to go into this matter in detail, but it was in shareholders' interests that he should refer to this matter, as they desired their customers to realize that they had done all they possibly could to meet their views. They also wished them to know that, notwithstanding their small production, they were arranging to outlay an additional large amount of capital on improvements in equipment and the modernizing of the plant, and in this way it should be possible for them to meet any additional demands for fuel supplies from their one colliery, in which the estimated reserves proved by development amount to close upon 7,000,000 tons of coal.

During the year under review they had entered into a contract for the supply of fuel to the Union Minière du Haut Katanga till June 30, 1930, and under this contract they were to supply about 5,000 tons of washed coal per month and 8,000 tons of coke.

They had lately had an opportunity of discussing their business with the general manager, Mr. A. R. Thomson, who left last week on his return to the colliery, and they particularly desired, at the meeting, to state how much they appreciated his loyal devotion to their affairs, and the excellent way in which their operations were carried on under a most efficient staff and an able body of men.

Sir Henry Birchenough seconded the resolution and it was carried unanimously.

TIN FIELDS OF NORTHERN NIGERIA, LTD.

Directors : Lord Lurgan (*Chairman*), C. G. Lush, Sir George C. Denton. *Manager :* W. R. Norton. *Secretary :* A. J. Culley. *Office :* Friars House, New Broad Street, London, E.C. 2. *Formed* 1909. *Capital issued :* £70,007.

Business : Operates alluvial tin property on the Bauchi Plateau, Northern Nigeria.

The ninth ordinary general meeting of the Tin Fields of Northern Nigeria, Ltd., was held on November 14 at Friars House, New Broad Street, London, E.C., Lord Lurgan (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said that the contract with Mr. D. Clemens over the company's properties, entered into in April, 1921, terminated in January last and a new contract with Mr. W. R. Norton was entered into on similar terms. The total output of tin concentrates produced under the two contracts was 101 tons, which realized, less freight and charges, £7,168 16s. 6d., or an average of £70 19s. 7d. per ton. After allowing for necessary depreciation, the year's working showed a loss of £1,204 2s. 4d. and although the position to-day was better than it was last year, he was far from wishing to convey the idea that they thought it was satisfactory. Under the existing circumstances, and in view of what had occurred in connection with the tin trade and industry during the past 12 months, a loss on the year was practically inevitable, and they could only hope that now that the price of tin seemed to be steadily improving, they would have a very different picture to put before shareholders next year.

The question had often been discussed since the slump in the tin industry as to whether it would not have been a better policy on the part of tin companies similarly situated to themselves to have closed down during all this bad period. He would like to say in this connection that the matter was most carefully considered and, taking into consideration what they would have had to forfeit in the way of losing their staff, disbanding their employees, and leaving the property entirely unprotected with the chance of what machinery, plant, etc., they possessed either being stolen or ruined, it was considered more advisable to continue working on the most economical lines possible, and he hoped that it would be found that this policy was the wisest in the end. He would like to add that immediately they found they were making a loss under the terms of the original contracts, they gave Mr. Norton three months' notice terminating his agreement. The whole question was most carefully reconsidered and a new contract embodying a flat rate per ton of tin as hitherto, but considerably to the advantage of the company, was prepared and in it was included a suggested bonus on a sliding scale, which it was believed would act as an incentive and inducement to Mr. Norton not only to agree to the new contract, but to further the company's interests in working the property. They were confident that he would accept the contract and trusted that, should he do so, it would be found to work advantageously. Under the proposed terms they would be able to meet their expenses even with tin in the neighbourhood of £150 to £155 per ton, while if the metal kept at its present level of about £180 per ton, they would make a very fair profit even on returns as relatively low as the past year.

The question of obtaining better outputs had received their serious consideration, and they arranged with Mr. Frank M. Lush to visit the property and submit his report as to its possibilities. This report was in a sense satisfactory, but they would be in a much better position to judge definitely of the state of affairs after they had seen Mr. Lush personally, which they hoped to do shortly. It was satisfactory to be able to state that if, after a full consideration of all the data which Mr. Lush would doubtless be in a position to give, they agreed with him and the market conditions warranted the installation of the machinery proposed, they had ample cash resources to meet the necessary expenditure. Before, however, any decision was arrived at in regard to this installation of machinery they would naturally have to carefully consider what Mr. Lush said in his report in regard to the making of a good road which would be suitable for motor transport, because tin and other stores were at present handled by donkey transport. Whether they would be able to induce the Government to meet their wishes in regard to this new road he could not forecast, but they would use every endeavour with the Colonial Office to secure their help in this matter. It was of almost vital importance to their property that they should have this road and they had already instructed Mr. Peele to take the necessary steps forthwith. Mr. Lush's concluding remarks in his report said that, provided this road was made and the plant installed, their property under efficient management would compare favourably with any other mine in Nigeria.

In regard to the conditions of the tin industry, recent reports from America and elsewhere indicated that there was a steadily increasing demand and that consumption was really becoming assured, but until conditions in the East, and, in fact, in Europe and the world generally, became more normal one could never guarantee anything in regard to the future of a commodity such as tin. The new contract for the sale of their tin provided for a smelting charge of £7 15s. per ton, compared with £10 which they had to pay at present. Although there was a rumour that the Government intended to increase their rents again, he hoped that this would not be entertained.

As to the present price of tin, there had been a very satisfactory rise in the price of metal. Whether the present conditions of the market were manipulative or otherwise it was not for him to say, but he sincerely trusted the rise was a genuine one and due to a general demand for tin.

To summarize the position, it would appear, on Mr. Lush's report, that for the time being their property should do fairly well in a small way if the price of tin kept up, and in the event of a road being made and their deciding to instal the machinery suggested, then they might hope to make a small undertaking into a successful and paying concern.

Sir George C. Denton seconded the resolution and it was carried unanimously.

BISICHI TIN CO. (NIGERIA), LTD.

Directors : James Gardiner (*Chairman*), W. S. Coutts, W. Graham, H. E. Nicholls, A. H. Young. *Engineers :* Lake & Currie. *General Manager :* C. F. Trousdell. *Secretary :* W. W. Evans. *Office :* 33, Cornhill, London, E.C. 3. *Formed* 1910, expanded 1920. *Capital issued :* £376,039 in shares of 10s. each.
Business : Operates alluvial tin properties on the Bauchi Plateau, Nigeria.

The eleventh annual general meeting of the Bisichi Tin Company (Nigeria), Ltd., was held on December 11, at the Cannon Street Hotel, London, E.C., Mr. James Gardiner (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1921, said that at the time of their last annual meeting economic conditions were so bad that it was reasonable to suppose that bottom had been reached, but this had not proved to be the case, and the tin mining industry had passed through a year of adversity even more severe than the previous one. This had caused their board many anxious moments in regard to the conduct of the company's business. The price of the metal continued to fall, and the average price realized by the concentrates produced during the year was only £111, as against £153 in the previous year, a difference of no less than £42 per ton, or over £17,000 on the year's production. A still further depreciation, which took place at the commencement of the present year, forced the directors to seriously consider the advisability of a suspension of operations (a step decided on by several Nigerian companies) until the return of better times. The question of the deterioration in all buildings, surface works, and stores, which followed a stoppage of work in a climate such as that of Nigeria, to say nothing of the dispersal of the labour force, was so serious a one that shareholders would not only approve of the decision to continue work on the restricted lines as defined last year, but agree that the small loss, really only a paper one, was far from unsatisfactory when everything was taken into consideration.

As regards labour, notwithstanding the comparatively restricted scale on which work was now being carried out, there was still a shortage and many more labourers could be employed if they were available. If this was the case now, he left it to their imagination to determine what would happen when the price of the metal justified work on a more extensive scale. The shortage would become more acute and, unless steps were taken to prevent it, there would again be competition for what there was, and a consequent increase in wage rates.

With regard to Nigeria, the period now being reviewed was one of work on a restricted scale. In last year's report their engineers drew attention to the fact that much of the ground being worked was outside the proved reserves, and on areas supposed to be of no value. This satisfactory feature continued, and in the Bisichi section a large area of ground which had been pitted and bored on several occasions with negative results had been treated by the plant quite satisfactorily. The many improvements which had been effected in the hydraulicking plant enabled the yardage treated during the year to be considerably in excess of last year, and, as compared with the time when it was first installed, its capacity had been increased nearly 50%. These improvements, directly reflected in working costs, had enabled gravel of comparatively low value to be worked successfully, and ground yielding little more than ¾ lb. per cu. yd. was being treated now at a profit. Although it was true they were working low-grade ground to-day, they were heading for the richest portions of the deposit on this the original Bisichi property, and largely increased returns might be expected as work progressed.

Prospecting was continued on E.P.L. 1060, and the estimated addition to reserves of 2,000 tons was confirmed by actual pitting and boring. The proved reserves on this area alone, therefore, now stood at no less than 6,486 tons. Applications had been made for Mining Leases aggregating 2,400 acres, which would cover the whole of this valuable area. On the other parts of the property 3,922 tons had been proved, thus making a total of 10,408 tons. This figure could not be considered other than satisfactory. No credit was taken for large areas of ground known to be payable, but which had not been systematically tested. This would undoubtedly substantially increase the total just given if accurate figures were available. No figures for the Ninghi property were included, although their engineers reported that there were possibilities of this proving an important section of the holding, whilst they still had other extensive areas quite untested which would undoubtedly add to reserves when times were sufficiently propitious to permit of the necessary work being undertaken.

A leat, seven miles in length, and having the large capacity of 40 cu. ft. of water per second, was approaching completion. The construction of this had been a somewhat big undertaking, as it had involved a considerable length of rock cutting and the erection of substantial flumes, but as it would be utilized for the working of the whole of the deposits on their Du Stream and E.P.L. 1060 areas the expenditure would, in the long run, prove a very valuable investment. The water supplied by this leat would be available during the coming year, and now, with the improved conditions brought about both by the considerable reduction in working costs and the appreciable rise in the price of the metal, an order had been placed for a plant consisting of a pipe-line and accessories for the working of the Du Stream areas, and, but for any unforeseen delays, this would be put into commission during the coming wet season. The pipe-line in question would serve a dual purpose, for it would later be utilized for the scheme which would supply E.P.L. 1060 areas with power. Before closing his remarks he would like to say how much the board regretted that the adverse circumstances had continued much longer than was anticipated when they met last year. While shareholders were much more pleased to meet the board when they were in a position to recommend a dividend, he was equally certain that they realized that times such as they had passed and were still passing through brought the board added work and increased anxieties, and that both board and shareholders had every cause to hope for more favourable conditions.

Mr. W. S. Coutts seconded the resolution, and it was carried unanimously.

COLOMBIAN CORPORATION, LTD.

Directors: F. W. Baker (*Chairman*), J. A. Agnew, F. D. Behrend, Lord Brabourne, A. Stanley Elmore, H. C. Porter. *General Manager:* W. A. Prichard. *Secretary:* G. E. Hounsom. *Office:* 341, Salisbury House, London, E.C. 2. *Formed* 1919. *Capital:* £510,000 in equal amounts of preference and ordinary shares.

Business: The development of the Constancia gold mine, Colombia.

The second ordinary general meeting of the Colombian Corporation, Ltd., was held on November 15 at River Plate House, London, E.C., Mr. Frederick W. Baker (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts to December 31, 1921, first dealt with the accounts. At the last annual meeting he had stated that, after allowing for such items as preliminary expenses and underwriting commission, interest on advances, loss on exchange, and administration expenses, the bulk of the sums received by way of application and allotment money, and loans, had been expended on the equipment and development of the property, leaving a balance as at November, 1921, of £86,000 available for the erection of the proposed plant and the construction of a road from Dos Bocas to the mine. Mr. Prichard, the manager, at the end of September, 1921, estimated the cost of completing the purchase and erection of the plant for the new mill, and for the construction of the road, at between £70,000 and £80,000, so that if this cost of construction worked out at the figure given, they would have had available sufficient working capital to put the company on a revenue-earning basis. He was sorry to say that the expenditures quoted at the last annual meeting were not going to prove sufficient to carry out the programme which they then had under consideration, the reasons being, firstly, the costs for the construction of the Dos Bocas road were proving to be much larger than were originally contemplated; secondly, Mr. Prichard had advised that the outlook at the Constancia mine warranted the construction of a plant on a larger capital outlay than was originally contemplated, so that by a comparatively small further expenditure the milling capacity of the mill could be more than doubled. The question of financing the further capital to meet these additional expenditures had given the board a good deal of thought, which had resulted in decisions which they would find practical and in the interests of the company. As already reported, Mr. Prichard, when it was decided to proceed with the construction of the Dos Bocas road (and without that road it would have been practically impossible to have equipped or operated economically the Constancia mine), secured a concession from the Colombian Government for a period of 40 years, which gave the Constancia Company the right to levy tolls on anyone using the road. As the Oroville Company, which owned all the ordinary shares in the Colombian Corporation, had decided, concurrently with the decision by this corporation to construct the Dos Bocas road, to build a river steamer for the purposes of facilitating the operations of their dredging properties in Colombia, the directors of that company felt that the construction and control of the Dos Bocas road, coupled with their river transportation service, would be an enterprise in which their funds could be more properly utilized than that this capital expenditure should be carried out by the Colombian Corporation. Arrangements were accordingly made whereby the whole of the capital outlay necessary to construct the Dos Bocas road would be carried out by the Oroville Company, Ltd., and suitable arrangements had been made to vest the road concession in the Oroville Company, Ltd. This transaction would relieve this corporation of a large capital outlay, while, at the same time, they would secure all the advantages following the construction of the road—namely, economies in freighting machinery and supplies to the property and in the future a reduction in operating costs.

As regards the cost of equipment, the estimates for the plant originally contemplated worked out at approximately £70,000. Acting under Mr. Prichard's advice, the directors had decided to erect a plant planned, as to its most important features, so that by additions later to the crushing capacity approximately 400 to 600 tons of ore could be treated daily as against the original tonnage contemplated of 150 tons. The additional expense resulting from the enlargement of the plant, together with the additional cost to the corporation in overhead charges, etc., resulting from the long delays in getting the mill into operation, left them with a deficiency of between £60,000 and £70,000. Suitable arrangements would in due course be made to finance this deficiency.

Shareholders would have read the very encouraging report made by Mr. Prichard. Mr. Prichard had no doubt in his own mind as to their securing large tonnages of a grade of ore which should make handsome profits. He stated in his report that he had no hesitation in saying that he believed that, after operating for a short time, they would require a mill capable of treating from 600 tons of ore per day, or perhaps 1,000 tons. He stated that on the basis of 85% recovery, \$8 head values, and \$3 costs, the net yield would be \$3·80 per ton, or \$34,200 per month, equal to £7,800 at the then rate of exchange. He estimated that the net earning capacity of the mine with a 300-ton mill would be from £70,000 to £100,000 per annum. With a 600-ton plant he stated that they would be able to double this profit, working a lower grade ore at a lower operating cost. To later on increase the plant to 600 tons per day would only require a small proportion of the expenditures required to instal the 300-ton plant now planned. If those figures were borne out as the result of actual operations, they had every reason to believe that they had got hold of a valuable property, one which should compensate them for all the long and wearisome delays that they had had in getting to work. These delays in a tropical country like Colombia, with bad transportation facilities and difficult labour conditions, were not unusual.

Mr. John A. Agnew seconded the resolution, which was then put to the meeting and carried unanimously.

FRONTINO AND BOLIVIA (S.A.) GOLD MINING CO., LTD.

Directors : S. W. Stephens (*Chairman*), Sir Henry P. Harris, R. C. Lyall, T. H. Alexander, Hugh O'Neill. *Consulting Engineers :* Pellew-Harvey & Co. *Secretary :* J. J. Truran. *Office :* 184, Gresham House, London, E.C. 2. *Formed* 1864. *Capital issued :* £140,000 in ordinary shares, and £23,390 in preference shares ; debentures, £50,000.

Business : Operates the Silencio gold mine, Colombia ; controls a subsidiary, the Marmajito Mines, Ltd., working a gold mine in the same district.

The eleventh annual general meeting of the Frontino and Bolivia (South American) Gold Mining Co., Ltd., was held on November 23, at 59a, London Wall, London, E.C., Mr. S. W. Stephens (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said the net receipts for the output for the past year were £101,939, as against £104,721 for the previous year ; the slight decrease was partly owing to diminished output and partly owing to exchange. In regard to the mining position, he had frequently stated that Silencio was a patchy mine, and was difficult to work. The lode was not wide ; it was tricky to follow, and assays varied from day to day ; it had, however, always proved constant in its inconsistencies. The experience of thirty years' working had proved each level as they had gone down to give fairly correct indication of what might be expected in the next. Lean periods had been regularly followed by fat ones, and the year 1922 was no exception to the rule. The reserve of ore in sight now amounted to 53,000 tons ready for stoping, and was valued at 17 dwt. per ton, equal to two years' supply for the mills. The results at No. 15 north were now gratifying, this level having hitherto been disappointing.

In regard to the Marmajito mine, at their last meeting he said : "I look upon the news from the Marmajito mine as the most encouraging part of the year's results," and he thought he could not do better than repeat those words. The drives at the different faces had been recommenced, and were all in good ore. In fact, they felt warranted in at once commencing the erection of a mill. That mill had been erected, and had commenced operations on July 1 last. So far, the returns had exceeded their estimates. Up to November 20, 2,100 tons had been crushed at an average yield of nearly £7 a ton. At a meeting of the Marmajito Co., at the end of last month, he had the pleasure of informing the shareholders that the board would be disappointed if the arrears of accumulated interest for the year ended December, 1921, were not wiped off in the early part of next year and the preference dividend for the year ending December, 1922, met when the accounts for that year were ready for consideration.

Sir Henry P. Harris seconded the motion, which was carried unanimously.

HAMPTON GOLD MINING AREAS, LTD.

Directors : Major-General Sir Newton J. Moore (*Chairman*), William Clark, H. J. Daly, J. H. Cordner-James, St. John Winne, John Waddington. *Acting Secretary :* J. Comper. *Office :* Finsbury House, London, E.C. 2. *Formed* 1920. *Capital issued :* £400,000.

Business : Development of gold mining properties at Hampton Plains, West Australia.

The second ordinary general meeting of Hampton Gold Mining Areas, Ltd., was held on November 27 at River Plate House, London, E.C.2, Sir Newton J. Moore (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said it would be observed that, after providing for prospecting, surveying, and general and administration expenses, there remained a profit surplus of £454. There was, however, additional expenditure of £2,490, which included £2,375 paid to the West Australian Government in settlement of the water contract, leaving a debit balance of £2,035. A year ago considerable attention was being directed to discoveries on Block 41, but no discovery of a permanent nature had so far been met with. A short time ago some good values were found on Crown lands about 60 chains north of this company's Block 42. A number of leases had been pegged out on Crown lands, and about six on the company's Block 42. Very little work had yet been done ; a dispute had arisen over the ownership of the original prospector's lease. With regard to the other portions of the company's property, the White Hope Gold Mining Co. and the Golden Hope Gold Mining Co. were working on Block 48.

The company had large funds in hand, and it was impossible to find a suitable outlet. The board had recently been approached by large shareholders holding approximately one-half of the issued capital, who desired a return in cash of part of the capital. Those shareholders had pointed out that there was little encouragement to capitalists to risk money in new gold mining ventures in that State, and they considered that a return of capital equivalent to £50,000 should be made. It was now proposed that the capital should be reduced by £200,000. Of this, £50,000, equal to 2s. 6d. per share, would be returned to the shareholders in cash, and the remaining £150,000 would be applied to writing off the revenue loss of £16,959 and the preliminary expenses, £2,371, and reducing the book value of the assets by £130,668. This would leave £200,000 of issued capital, which it was proposed should be divided into 5s. shares. They had received proxies from the holders of 271,120 shares, being 99% in favour of this scheme.

The report and accounts were unanimously adopted, and at an extra-ordinary general meeting resolutions to carry into effect the reorganization of the capital as outlined by the Chairman were also carried unanimously.

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